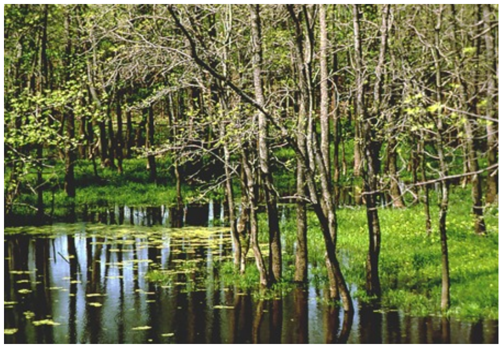
QUALITY ASSURANCE PROGRAM PLAN

Surface Water Monitoring & Assessment
MADEP-Division of Watershed Management
2005-2009






Massachusetts Department of Environmental Protection
Division of Watershed Management
Watershed Planning Program
627 Main St, Worcester, MA. 01608

CN # 225.0
MS-QAPP-25
April, 2005
(Rev. #1)

Massachusetts Department of ENVIRONMENTAL PROTECTION

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COMMONWEALTH OF MASSACHUSETTS

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

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DIVISION OF WATERSHED MANAGEMENT

QUALITY ASSURANCE PROGRAM PLAN

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MADEP-Division of Watershed Management
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DWM Control Number: 225.0
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(Dennis Dunn) (Date)

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Foreword:

This document is the formal monitoring program Quality Assurance Program Plan (QAPP) of the Massachusetts Department of Environmental Protection (MADEP), Division of Watershed Management's (DWM) Watershed Planning Program. It applies to the generation and use of surface water quality data by DWM for a five year period (2005 through 2009). Annual addendums to this program QAPP shall be provided to EPA-Region 1 and other users for any programmatic changes affecting the monitoring program.

This five-year program QAPP shall be annually supplemented by project-specific Sampling and Analysis Plans (SAPs), which provide detailed information regarding individual project organization, tasks, background, sampling design and non-direct measurements (i.e., sections A4-A6, B1 and B9 only).

For additional information not contained in this QAPP, see other applicable and current DEP QAPPs, SAPs, Standard Operating Procedures (SOPs), laboratory QA Plans etc. contained on the DWM QAPP CD.

QAPP Format:

The format of this QAPP follows EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5, March 2001). Additional guidance documents used to develop this QAPP include:

- Region I, EPA-New England Compendium of Quality Assurance Project Plan Guidance, October, 1999.
- EPA Guidance for the Data Quality Objectives Process, QA/G-4, August, 2000
- EPA Guidance for Quality Assurance Project Plans, QA/G-5, December, 2002
- EPA Guidance on Choosing a Sampling Design for Environmental Data Collection, QA/G-5S, December, 2002
- EPA's Volunteer Monitor's Guide to Quality Assurance Project Plans, September 1996.

Acknowledgments:

Many thanks to the following DWM staff persons who helped to formulate and review this multi-year program QAPP:

- Richard Chase (NEIWPCC/MADEP; QAPP preparation)
- Alice Rojko
- Katie O'Brien
- Stella Tamul
- Susan Connors
- Christine Duerring
- Elaine Hartman
- Joan Beskenis
- Jane Ryder
- Brian Friedmann
- Mark Mattson
- Bob Nuzzo
- John Fiorentino
- Arthur Johnson
- Greg DeCesare
- Bob Maietta
- Pete Mitchell
- Bill Dunn
- Mike DiBara
- Arthur Screpetis
- Rick McVoy
- Steve Halterman
- Russell Isaac, and
- Tom Dallaire

In addition, valuable assistance was provided by the following MADEP staff, as well as other agencies and groups:

- MA. Executive Office of Environmental Affairs (EOEA)
- Lisa Touet, Jim Sullivan, Michael Bebirian and Oscar Pancorbo, DEP Wall Experiment Station (review of analytical issues for WES lab)
- Charles Porfert and Mary Jo Feuerbach, EPA (QAPP review and approval)
- Tom Faber, EPA (EPA monitoring assistance capabilities)
- MA Dept. of Conservation and Recreation (DCR), formally DEM (current and future monitoring plans)
- MA Dept. of Marine Fisheries (current and future monitoring plans)
- MA Dept. of Fish and Game (current and future monitoring plans)
- USGS (current and future monitoring plans)
- US Army Corps of Engineers (current and future projects)
- Misc. volunteer monitoring groups (current and future monitoring plans)

Document Availability:

The 2005-2009 QAPP is mainly available in electronic format (CD and DEP web site: http://www.mass.gov/dep/water/resources/qualmgt.htm.

CDs and hard (paper) copies of this QAPP can be made available upon special request to: Richard Chase at 508-767-2859, @ richard.f.chase@state.ma.us; MADEP-Div. of Watershed Management, 627 Main St., Worcester, MA. 01608.

In addition, copies of the QAPP CD (including SOPs, SAPs, etc.) have been submitted to the State Library at the State House in Boston; these copies are subsequently distributed as follows:

- On shelf; retained at the State Library (two copies);
- Microfilmed retained at the State Library;
- Delivered to the Boston Public Library at Copley Square;
- Delivered to the Worcester Public Library;
- Delivered to the Springfield Public Library;
- Delivered to the University Library at UMass, Amherst;
- Delivered to the Library of Congress in Washington, D.C.

This information can be made available in alternate formats upon request by contacting the American Disabilities Act (ADA) Coordinator at 617-574-6872 or 617-556-1057.

Disclaimer:

References to trade names, commercial products and manufacturers in this QAPP does not constitute endorsement.

A2. CONTENTS

Figures

Tables

List of Acronyms:

ACOE………………… US Army Corps of Engineers
BMP…………………… Best Management Practice
BOD…………………… Biochemical Oxygen Demand
BPJ……………………. Best Professional Judgment
BRP…………………… Bureau of Resource Protection
COD…………………. Chemical Oxygen Demand
CMR…………………… Code of Massachusetts Regulations
CN .... Control Number (documents)
CWA…………………… Clean Water Act
CWF…………………… Cold Water Fishery

DCR……………….	Massachusetts Department of Conservation and Recreation
DMF……………………	Division of Marine Fisheries
DO………………………	Dissolved oxygen
DFG.……………………	Department of Fish and Game
DQO ……………………	Data Quality Objective
DWM……………………	Division of Watershed Management
DWP…………………	Drinking Water Program
EOEA………………….	Executive Office of Environmental Affairs
EPA..…………………..	United States Environmental Protection Agency
EPT…………………….	Ephemeroptera, Plecoptera, Trichoptera
FWA	Fluorescent Whitening Agents
ISO ……………………	International Organization for Standardization
MA DEP……………….	Massachusetts Dept. of Environmental Protection
MassGIS………………	Massachusetts Geographic Information System
MDFW…………………	Massachusetts Division of Fisheries and Wildlife
MDPH…………………	Massachusetts Department of Public Health
MDL……………………	Method Detection Limit
MPN……………………	Most probable number
MWWP…………………	Massachusetts Waterwatch Partnership
NPDES…………………	National Pollutant Discharge Elimination System
PAH……………………	Polycyclic Aromatic Hydrocarbon
PALIS…………………	Pond and Lake Information System
PCB……………………	Polychlorinated biphenyl
POTW…………………	Publicly Owned Treatment Works
QAP …………………	Quality assurance plan (laboratory)
QAPP…………………	Quality assurance project plan
QA/QC…………………	Quality assurance/ quality control
QMP …………………..	Quality Management Plan
RBP……………………	Rapid bioassessment protocol
RDL…………………….	Reporting Detection Limit
SARIS…………………	Stream and River Inventory System
SMART…………………	Strategic Monitoring and Assessment of River basin Teams
SWQS………………….	Surface Water Quality Standards
TMDL……………………	Total maximum daily loads
TNTC……………………	Too numerous to count
TOXTD………………….	MA DEP DWM Toxicity Testing Database
TRC………………………	Total residual chlorine
TSS………………………	Total Suspended Solids
USGS……………………	United States Geological Survey
WBID…………………	Waterbody Identification Code
WBS…………………	Waterbody System Database
WES…………………	Wall Experiment Station
WWF…………………	Warm Water Fishery
WWTP……………….	Waste Water Treatment Plant

List of Units:

cfs .... cubic feet per second
cfu .... colony forming unit
mg/Kg................................ milligram per kilogram
mg/L .... milligram per liter
mg/m^3................................ milligram per cubic meter
mi^2 .... square mile
mL .... milliliter
µg/kg .... microgram per kilogram
µg/L .... microgram per liter
µS/cm................................ Microsiemens per centimeter
ng .... nanogram
ppb .... parts per billion
ppm .... parts per million
SU .... standard units

A3. DISTRIBUTION LIST

The following persons and groups have been made aware of this QAPP and been given the opportunity to review and comment on the draft:

- Dennis Dunn
- Arthur Johnson
- Richard McVoy
- Christine Duerring
- Eben Chesebrough
- Steve Halterman
- Russell Isaac
- Arthur Screpetis
- Jeffrey Smith
- Alice Rojko
- Katie O'Brien
- Stella Tamul
- Susan Connors
- Pete Mitchell
- Bill Dunn
- Elaine Hartman
- Joan Beskenis
- Greg DeCesare
- Brian Friedmann
- Mark Mattson
- Bob Nuzzo
- John Fiorentino
- Bob Maietta
- Laurie Kennedy
- Mike DiBara
- Tom Dallaire
- Gerry Szal
- Beth McCann
- Warren Kimball
- Therese Beaudoin
- Lisa Touet (WES lab)
- Jim Sullivan(WES lab)
- Oscar Pancorbo (WES lab)
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- Mary Jo Feuerbach (EPA Region 1)
- MA DCR
- MWWP
- NHDES
- RIDEM
- VTDEC
- CTDEP

A hard copy (CD) has been placed in the DWM library for general reference and electronic copies have been placed on the DWM network drive (W:\dwm\sop\cn225.0), the DEP network drive (Y:\brpresources\QAPP) and the DEP internet site: http://www.mass.gov/dep/water/resources/qualmgt.htm.

A4. PROGRAM DESCRIPTION & ORGANIZATION

The Massachusetts Department of Environmental Protection (MADEP), Division of Watershed Management (DWM) is responsible for a variety of programs aimed at implementing the Clean Water Act (CWA). Among these are:

- Watershed-based Monitoring, Assessment and Implementation
- Development of Total Maximum Daily Load (TMDL) Implementation Plans
- Wastewater Discharge Permitting
- Stormwater NPDES Program
- Water Withdrawal Permitting Program
- Non-Point Source (NPS) Program, and
- Grants and Loans Program

Monitoring and data management performed as part of these programs meet the ten basic elements of a State water resource monitoring program outlined by EPA and the prerequisites of CWA Section 106(e)(1). These ten elements are generally as follows:

1. *Monitoring Program Strategy:* A comprehensive long-term monitoring program strategy that serves Massachusetts water quality management needs and addresses all State waters, including streams, rivers, lakes, reservoirs, estuaries, coastal areas, wetlands, and groundwater.

2. *Monitoring Objectives:* Monitoring objectives that are effective in generating data that serve management decision needs

3. *Monitoring Design:* An approach and rationale for selection of sample sites that best serve the monitoring objectives. The monitoring program ultimately will integrate several monitoring designs (e.g., fixed station, intensive and screening-level monitoring, rotating basin, etc.) to meet the full range of decision needs.

4. *Core and Supplemental Water Quality Indicators:* Core indicators are selected to represent each applicable designated use, plus supplemental indicators selected according to site-specific or project-specific decision criteria.

5. *Quality Assurance:* Quality management plans and quality assurance program/project plans are developed and implemented (maintained and peer reviewed in accordance with EPA policy) to ensure the scientific validity of monitoring and laboratory activities, and to ensure that State reporting requirements are met.

6. *Data Management:* An electronic data system is developed and utilized for water quality, fish tissue, toxicity, sediment chemistry, habitat, biological data, with timely data entry (following appropriate metadata and State/Federal geo-locational standards) and public access.

7. *Data Analysis/Assessment:* The State has a methodology for assessing attainment of water quality standards based on analysis of various types of data (chemical, physical, biological, land use) from various sources, for all waterbody types and all State waters. The methodology includes criteria for compiling, analyzing, and integrating all readily available and existing information (e.g., volunteer monitoring data, discharge monitoring reports).

8. *Reporting:* The State produces timely and complete water quality reports and lists called for under federal regulatory requirements.

9. *Programmatic Evaluation:* The State, in consultation with its EPA Region, conducts periodic reviews of each aspect of its monitoring program to determine how well the program serves its water quality decision needs for all State waters, including all waterbody types.

10. *General Support and Infrastructure Planning:* Current and future resource requirements (funding, staff, training, laboratory resources) for fully implementing the monitoring program strategy.

DEP's emphasis on a "quality system" approach forms the basis for DWM's generation of usable data of documented quality. This approach is documented in the EPA-approved **DEP Quality Management Plan (QMP) for Federally Funded Programs** (DEP 2001). The QMP is consistent with EPA requirements (QA/R-2). The current QMP approval lasts until October, 2006. At that time, another five-year EPA approval shall be requested.

Via the QMP, program and project QAPPs, SOPs and other plans and policies, DWM strives to set and maintain a high standard for all its work.   DWM's Worcester operation is not ISO-certified for any applicable standard, nor is it currently seeking certification for product/service quality (ISO 9001) or an Environmental Management System (ISO 14001).

Figure 1 provides an overview of specific personnel involved in data collection and use.   Table 1 provides more detailed descriptions of the roles and responsibilities for these DWM staff and state/contract laboratory staff.

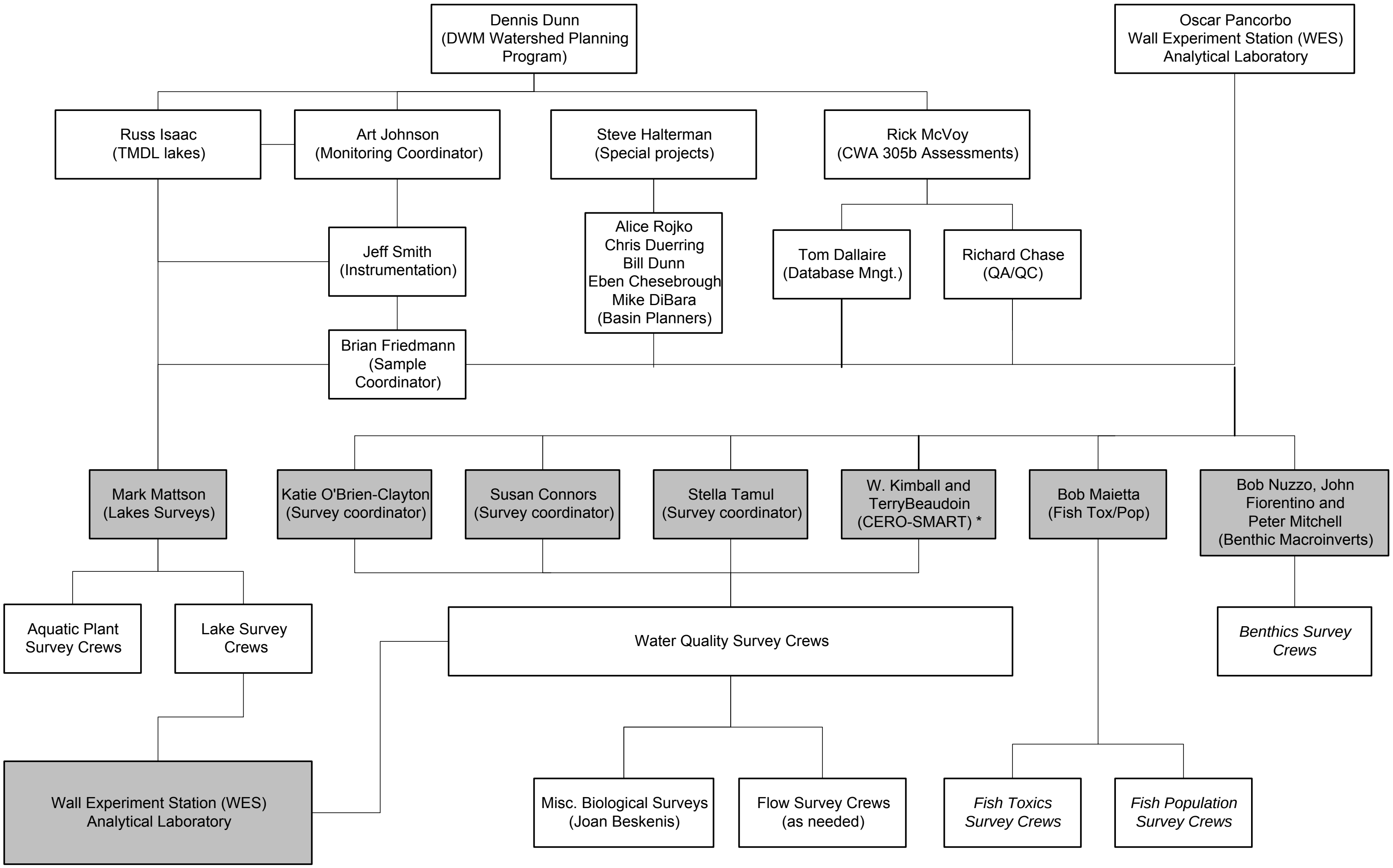

Figure 1: DWM Organizational Chart for Field Monitoring and Sample Analysis (general)

* non-DWM

Table 1. Program Roles and Responsibilities related to monitoring and data use

Project Personnel, Title and Affiliation	Roles and Responsibilities
Rick Dunn, Program Supervisor, Watershed Planning (DWM)	Responsible for overall management of administrative and technical work by Watershed Planning.
Steve Halterman, Project Coordinator; (DWM)	Responsible for oversight and management of special projects, both statewide and basin-specific (in coordination with DWM basin planners).
Arthur Johnson, Environmental Monitoring Coordinator (DWM)	Responsible for the planning and coordination of all environmental monitoring by DWM. This includes technical oversight, staff assignments and scheduling.
Rick McVoy, Assessment Coordinator, (DWM)	Responsible for completion of CWA Section 305(b) data collection and assessment, including technical oversight, especially with regard to lake surveys (limnology, aquatic plant ID).
Russ Isaac, TMDL Coordinator (DWM)	Responsible for the development and implemention of Total Maximum Daily Loads (TMDLs) for State waters. Also provides technical oversight in the development and evaluation of ambient water quality standards.
Oscar Pancorbo, Director Wall Experiment Station (WES) Lab, Lawrence, Ma.	Responsible for overall lab management, technical oversight and lab data production related to the performance of water quality analyses according to established EPA/other methods and WES laboratory Standard Operating Procedures (SOPs).
Richard Chase, Quality Control Analyst, (DWM)	Responsible for overall quality assurance and quality control for environmental monitoring and data handling at DWM, including SOP development, training, data review and validation, QC reporting, lab coordination and QAPP development.
Alice Rojko, Chris Duerring, Bill Dunn and Eben Chesebrough, Mike DiBara; Basin Planners (DWM)	Responsible for identifying clear objectives to address needs and prioritized actions in each basin, in coordination with survey coordinators.
Tom Dallaire, Database Manager (DWM)	Responsible for database management at DWM, including downloading and processing of raw multi-probe data, data entry, database development and database exports.
Stella Tamul, Susan Connors, Katie O'Brien-Clayton, Greg DeCesare (2005 only), Pete Mitchell; Survey Coordinators (DWM)	Responsible for designing sampling and analysis plans and coordinating surveys for specific watershed monitoring projects

Project Personnel, Title and Affiliation	**Roles and Responsibilities**
Jeff Smith, multiprobes, instrumentation and equipment (DWM)	Responsible for calibration and maintenance of multi-probe instruments and other instrumentation as applicable. Also, helps train DWM staff in the proper use of the multi-probes and other equipment.
Brian Friedmann, sample bottle coordinator (DWM)	Responsible for the preparation of sample containers and field blanks, and for obtaining the necessary preservatives for analytical samples from WES.
Mark Mattson, lakes survey coordinator (DWM)	Responsible for developing the sampling plan/design and QAPP for the baseline lakes TMDL sampling, as well as for any special training (e.g., aquatic plant surveys) for lake monitoring crews. Also, training for DWM lab color analysis.
Water quality survey crews (DWM) (DWM staff, seasonal employees, regional office staff and volunteer assistance as needed)	Under the direction of the survey coordinators and survey crew leaders, the water quality field crews follow the sample collection techniques and multi-probe use procedures contained in DWM SOPs.
Flow survey crews (DWM) Elaine Hartman, Kathleen Keohane, Mark Mattson, Bob Maietta, Richard Chase, Jeff Smith, Brian Friedmann, Others (TBD)	Responsible for the accurate measurement of ambient stream/river flows per DWM SOPs (CN 68.0 through 68.6).
Bob Maietta and Greg DeCesare (2005 only), Fish Biologists (DWM)	Responsible for the coordination of fish tissue and population surveys, and associated tasks including sample preparation, and validation and management of biological data. DEP representatives on interagency fish kill and fish toxics committees (Maietta) and for herbicide applications (DeCesare)
Bob Nuzzo, John Fiorentino and Peter Mitchell, Biologists (DWM)	Responsible for sampling, analysis and generation of valid data for benthic macroinvertebrates in rivers and streams, in order to assess the aquatic life use.
Lisa Touet, Jim Sullivan, Michael Bebirian, Ron Stoner, Val Casella and others (lab managers) Wall Experiment Station (WES) Lab, Lawrence, Ma.	Responsible for specific lab management (microbiology, inorganic, organic, LIMS, etc.), QC and data production at WES.
Misc. labs under contract	Responsible for overall lab management and technical oversight regarding the performance of water quality analyses and submittal of validated data to DWM in compliance with contractual arrangements.

NOTE FOR SECTION A5:
SEE ALSO ANNUAL SAMPLING & ANALYSIS PLANS (SAPs) FOR ADDITIONAL, PROJECT-SPECIFIC OBJECTIVES

A5 PROGRAM GOALS AND OBJECTIVES

DWM monitoring efforts support DEP programmatic functions to preserve, protect, assess and restore water quality. Due to agency resource limitations, the assessment of waterbody conditions in Massachusetts is carried out on a 5-year cycle, in which selected surface waters in each watershed are sampled during Year 2 of the cycle. See Figure 2.

Quality assurance for watershed monitoring by the DWM, as detailed in this and other DWM Quality Assurance Program Plans (QAPP), is provided to ensure implementation of an effective and efficient sampling design, to meet programmatic goals and to provide data meeting specific data quality objectives. The QAPP process is one part of a programmatic focus on data quality.

DWM main *programmatic objectives* related to surface water quality monitoring are as follows:

- Collect chemical, physical and biological data to assess the degree to which designated uses, such as primary and secondary contact recreation, fish consumption, aquatic life, aesthetics, are being met in waters of the Commonwealth **(CWA 305(b) purposes)**
- Collect chemical, physical and biological data to support analysis and development of implementation plans to reduce pollutant loads to waters of the Commonwealth **(CWA 303(d) purposes)**
- Screen fish in selected waterbodies for **fish tissue contaminants** (metals, PCBs and organochlorine pesticides) to provide for public health risk assessment
- To the extent feasible, **locate pollution sources** and promote and facilitate timely correction
- Over the long term, collect water quality data to enable the determination of **trends** in parameter concentrations and/or loads.
- Develop **new or revised standards**, which may require short-term research monitoring directed towards the establishment or revision of water quality policies and standards.
- Measure the **effectiveness of water quality management projects or programs** (such as the effectiveness of implementing a TMDL Best Management Practices (BMP) for the control of nonpoint pollution at a particular site, or of a comprehensive assessment of a state-wide policy or permitting program).

Limited staffing and resources, combined with more water resources in need of assessment than can realistically be assessed, make the decisions on what to sample for and where to do it very difficult. In selecting sample types, locations, parameters and survey frequencies, each decision is based on a collective, working knowledge of the basin (among DWM, regional DEP offices, etc.), review of relevant historical data and a prioritization of monitoring needs. Emphasis is placed on assessing water quality with respect to Massachusetts' water quality standards and criteria, and on the development of implementation plans to reduce point and non-point pollutant loads.

A5.1 Evolution of a Statewide Water Quality Network for Massachusetts

Recent DEP publications (USGS 2001; DWM 2004) recommend monitoring approaches for Massachusetts that meet multiple needs of local, state, and federal agencies, and that provide an effective framework for meeting the programmatic objectives of waterbody assessment, protection and restoration. The DEP/USGS report focused on a network involving five tiers as follows:

- ***Tier I monitoring*** involves a basin-based assessment of existing surface water quality conditions to reflect mandates of Section 305 (b) of the Clean Water Act (CWA). Tier I is statewide in scale, comprehensive, repeated at regular intervals, and can be probabilistic or deterministic in design. The goal of Tier I monitoring is to increase the number of stream miles and lake acres that are assessed and to reduce the historical bias towards problem areas.

- ***Tier II monitoring*** involves determining contaminant loads carried by major rivers at strategic locations (e.g. mouths of major rivers, state borders).

- ***Tier III monitoring*** is targeted monitoring to identify impaired waterbodies as required by Section 303(d) of the CWA, to determine causes and sources of impairments, to identify pollution sources or "hot spots" and to allow other site-specific evaluations.

- ***Tier IV monitoring*** is to develop Total Maximum Daily Loads (TMDLs) for specific waterbodies.

- ***Tier V monitoring*** is compliance-based monitoring to meet regulatory and permit limits.

Because it is not possible currently to implement such a network in its entirety, DWM monitoring consists of collecting data under Tiers I, III and IV of the statewide water quality network, with emphasis on perceived potential problem areas, such as downstream of known/potential pollution sources.

The 2004 DWM monitoring strategy report (DEP 2004) expands on the network concept by proposing specific improvements and prioritized actions as part of a long-term strategy. This strategy places the highest priority on monitoring elements aimed at knowing the condition of Massachusetts' waters, finding pollution sources and developing strategies for restoring impaired waters. Monitoring to detect trends and loadings is the next highest priority, and probabilistic monitoring designs are given the lowest priority.

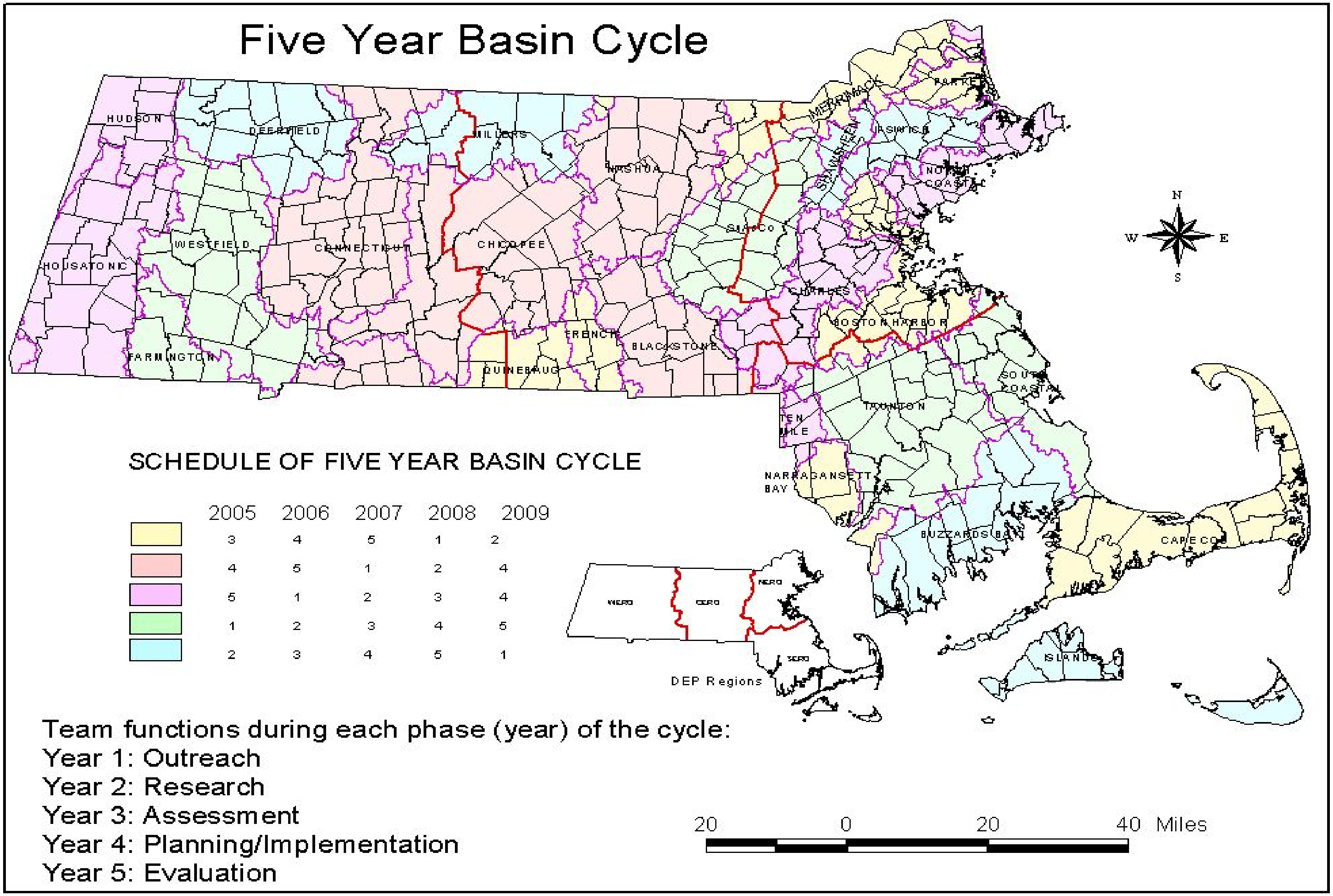

Figure 2: Five-Year Basin Cycle (2005-09)

A6 PROJECT SCHEDULING & COORDINATION

The typical schedule by which DWM plans and implements its monitoring strategy every year is structured not only by available staff and equipment and the five-year watershed cycle, but also by current, non-watershed-based projects.

In general, the schedule for planning and conducting DWM surveys and using data to generate reports and make decisions is outlined in Table 2 for Years 1-3.

Coordination with other groups, such as EPA, USGS, DCR, DFG, DEP consultants, volunteer monitoring associations and others, is typically done to enhance data collection and minimize duplication of effort. For example, DWM typically requests and receives monitoring assistance from EPA-NE for types of monitoring which EPA is typically more suited for, such as ambient toxicity testing and discharge compliance monitoring. Also, volunteer groups are often sampling for the same desired parameters at similar times and locations. In these cases, DWM may elect to rely on these efforts based on a thorough review of the group's QAPP and history of producing usable data. DWM also coordinates with the DEP Central Regional office SMART monitoring program when DWM is monitoring in the Central region watersheds (Chicopee, Nashua, Blackstone, French & Quinebaug, Concord and Millers Watersheds).

Table 2: Major Tasks and Project Timeline for DWM Monitoring Projects (Year 1-3)

Activity	Approx. Time of Initiation	Approx. Time of Completion	Deliverable
Background data collection and outreach	Year 1 (Fall)	Year 1 (Fall-Winter)	Text for SAP
Project planning meetings	As needed	As needed	Meeting summary memos
Field reconnaissance (visits for station selection, logistics, etc.)	Year 1 (Fall)	Year 2 (Spring)	Finalize sampling stations for SAP
Sampling & Analysis Plan (SAP) development and approval for each project	Year 1 (Fall-Winter)	Year 2 (Spring)	Approved SAP
Revisions to/approval of generic Quality Assurance Program Plan (QAPP)	Year 2 (Spring)	Year 2 (Spring)	Approved QAPP
Survey training, scheduling, preparation and coordination	Year 2 (Spring)	Year 2 (Fall)	All project staff prepared for field work
Field Surveys (water quality, biological, habitat, etc.)	Year 2 (Spring)	Year 2 (Fall)	Completed and successful surveys
Field audits	Year 2 (Spring)	Year 2 (Fall)	Completed Audit Reports
Lab Audits	Year 2 (Spring)	Year 2 (Fall)	Completed Audit Reports
Water quality field data entry and LIMS EDD data transfer from lab(s) into database	Year 2 (Summer)	Year 2 (Fall-Winter)	Draft data entered and ready for preliminary QC
Biological sample preparation (fish toxics), processing and taxonomy (benthic macroinvertebrates)	Year 2 (Summer)	Year 2 (Fall-Winter)	Preliminary results
Biological data entry, QC and reduction/analyses (metric calculations, scoring)	Year 3 (Winter-Spring)	Year 3 (Spring)	Final biological data ready for use
Water quality data validation and verification	Year 3 (Winter-Spring)	Year 3 (Spring)	Final water quality data ready for use
Report production for draft and final project technical memoranda and assessment reports	Year 3 (Spring)	Year 3 (Summer)	Final technical memoranda and assessment reports

A7 DATA QUALITY OBJECTIVES AND CRITERIA

The parameter-specific data quality objectives (DQOs) for DWM monitoring are outlined in Table 3. Although failure to meet these planned DQOs may subject project data to qualification or censoring during post-monitoring quality control review, DWM's evaluation of data quality is flexible and uses these objectives as guidance.

In general, DWM requires low level analyses for most of the analytical determinations on DWM samples. Although results for individual analytes vary depending on waterbody pollutant levels, many of the results are often at or near the method detection limits.

Detection limit information in Table 3 is based on the latest determinations by DEP's Division of Environmental Analysis, Wall Experiment Station (WES) and DWM labs. DWM delivers most (and in some cases all) of its samples to these two labs.

The most important QC objectives--- PARCC (precision, accuracy, representativeness, completeness and comparability) are discussed below, along with other data quality criteria, such as holding time, sensitivity and detection limits.

A7.1 Accuracy

Accuracy is determined by how close a reported result is to a true or expected value.

Laboratory accuracy will be determined by following the policy and procedures provided in the laboratory's Quality Assurance Plan and analyte-specific DWM SOPs. These generally employ estimates of percent recoveries for known internal standards, matrix spikes and performance evaluation samples, and evaluation of blank contamination.

Depending on the analyte, specific accuracy objectives can be concentration-based (e.g. +/- 0.010 mg/l @ < .05 mg/l and + /- 20% @ > .05 mg/l), or can be defined in terms of percent recovery percentages (e.g. 80-120 % recovery of matrix spike/PE sample).

Accuracy for multi-probe measurements is tested prior-to-use using standards that bracket the measurement range and after use checked against standards to determine if probes remained in calibration at the end of the measurement period. A NIST-certified thermometer is used to periodically check thermometer accuracy. Lower limit accuracy for dissolved oxygen (DO) is checked using a zero DO standard (starting in 2006, when and where low DOs are expected). The post-sampling checks of each unit ensure that the readings taken during the survey(s) were within QC acceptance limits for each multi-probe analyte.

A7.2 Precision

Precision is a measure of the degree of agreement among repeated measurements and is estimated through sampling and analysis of replicate samples.

Laboratory precision of lab duplicates will be determined by following the policy and procedures provided in the laboratory's Quality Assurance Plan and individual DWM SOPs. This varies depending on the lab and analyte, but typically involves analysis of same-sample lab duplicates and matrix spike duplicates.

Overall precision objectives using relative percent difference (RPD) of field duplicate samples vary depending on the parameter and typically range from 10-25% RPD. DWM recognizes that precision estimates based on small numbers can result in relatively high RPDs (due to small number effect).

Precision of the multi-probe measurements can be determined by taking duplicate (via a second placement of the unit) readings at the same station location. This is sometimes performed for lake surveys. Multi-probe precision objectives generally range from 5-10 % RPD depending on the parameter.

A7.3 Representativeness

Representativeness refers to the extent to which measurements actually represent the true environmental condition. Sampling stations are always selected to ensure that the samples taken represent typical field conditions at the time and location of sampling, and not anomalies due to uncommon effects. In many cases, stations are chosen to evaluate site-specific impacts (i.e. "hot spots") using the same attention to ensuring representativeness.

A7.4 Completeness

Completeness refers to the amount of valid data collected using a measurement system. It is expressed as a percentage of the number of valid measurements that should have been collected. For DWM monitoring, the completeness criterion is typically 80-100%. This assumes that, at most, one event out of five might be cancelled for some reason that could cause an incomplete data set with up to 20 % of the planned-on data not obtained.

A7.5 Comparability

Comparability refers to the extent to which the data from a study is comparable to other studies conducted in the past or from other areas. For DWM monitoring, the use of standardized sampling and analytical methods, units of reporting, and site selection procedures help to ensure comparability of data. Review of existing data and methods used to collect historical data have been reviewed and taken into account in the sampling design. Efforts to enhance data comparability have been made where possible and appropriate.

A7.6 Detection Limits

In general, the detection limits define the smallest amount of analyte that can be detected above signal noise and within certain confidence levels. Typically, Method Detection Limits (MDL) are calculated in the laboratory by analyzing a minimum of seven low-level standard solutions using a specific method. (Detection limits in the traditional sense do not apply to some measurements such as pH and temperature that have essentially continuous scales.) Multiplication factors are typically applied to MDL values by labs to express Reporting Limits (RL or RDL), which define a level above which there is greater confidence in reported values. Where low-level results are needed, DWM often requests results reported down to the MDL with or without lab qualification (rather than "<RDL").

A7.7 Holding Times

Most analytes have standard holding times (maximum allowed time from collection to analysis) that have been established to ensure analytical accuracy. All bacteria sampling and analyses for surface waters adhere to the 6 hour delivery and 8 hour maximum holding times, regardless of method.

A7.8 Sensitivity

This is the ability of the method or instrument to discriminate between measurement responses. The specifications for sensitivity are unique to each analytical instrument and are typically defined in laboratory Quality Assurance Plans (QAP) and SOPs.

A7.9 Standard Protocols

The use of approved field and lab SOPs by DWM and its agents provides some assurance that programmatic data quality objectives shall be met consistently. Note: two methods for TP are listed in Table 3; the USGS alkaline persulfate method for TP is currently being tested at the MADEP WES laboratory, and may or may not be used in 2005 (and beyond). The primary analytical method employed for TP remains SM 4500-P-E.

A7.10 Performance Auditing

Scheduled and unscheduled **field audits** are typically performed by DWM QC staff to evaluate implementation of field methods, consistency with this QAPP and compliance with DWM SOPs for all projects. Field audits attempt to evaluate at least one survey per watershed and, ideally, each survey crew member a minimum of one time over the monitoring period (this equates to evaluating field performance of approx. 15-20 persons).

Proficiency testing of laboratory analytical accuracy is typically performed for nutrients. These are single- or double-blind **lab QC checks** using DWM-prepared solutions and purchased QC check samples. Check samples are also run to evaluate method performance for DWM's use of Colilert® for E. coli bacteria analysis ("single-blind"; unknown type, presence/absence type test only) at the DWM Lab in Worcester. All audit results are compared to "true" values/results and evaluated against acceptance limit criteria. Results are also provided to lab analysts and survey coordinators.

Table 3. Data Quality Objectives for DWM Monitoring (all values in mg/l, except as noted)

Analyte	Units	Expected Range (approx.)	Project Quant. Limit PQL	Analytical Method MDL	Achievable Laboratory MDL	Laboratory RDL, if provided	Accuracy (+/-)	Overall Precision (RPD or other)	Resolution
Multi-Probe (Hydrolab® Series 3, 4a and 5; YSI 600XLM)									
Temperature	°C	0-30	NA	NA	NA	NA	0.15 (0.10)	5%	0.01 °C
Depth	meters	0-10	NA	NA	NA	0.1	0.45 (0.3)	10%	0.1 m
pH	standard units	4-9	NA	NA	NA	NA	0.2	+/- 0.1 pH units	0.01
Dissolved Oxygen	mg/L	0-14	NA	NA	NA	0.2	0.2	5%	0.01 mg/L
Specific Conductance	μS/cm	75-700	NA	NA	NA	NA	1% of range	5%	4 digits
% Oxygen Saturation	%	0.2-110	NA	NA	NA	NA	NA	5%	NA
Turbidity	NTU	0.1-100	NA	NA	NA	NA	5% of range	10%	0.1 NTU
Water Quality, Flow, Macroinvertebrates, Habitat, Fish Community, Periphyton and Aquatic Plants									
Flow	cfs	variable	NA	NA	NA	NA	15% (estimated)	10%	NA
Total Phosphorus (TP) (SM 4500 P-E)	mg/L	0-0.15	0.005	0.001-.0005	0.005	0.015	80-120% recovery of QC standard and lab-fortified matrix <50 ppb, 5 ppb >50 ppb, 10%	<50 ppb, 5 ppb >50 ppb, 10% RPD	NA
Total Phosphorus (TP) (USGS I-4650-03 using alkaline persulfate digestion)	mg/L	0-0.15	0.010	0.007	0.010	0.030	80-120% recovery of QC standard and lab-fortified matrix <50 ppb, 5 ppb >50 ppb, 10%	<50 ppb, 5 ppb >50 ppb, 10% RPD	NA
Dissolved Reactive Phosphorus (DRP)	mg/L	0-0.15	0.005	0.001-.0005	0.005	0.015	80-120% recovery of QC standard and lab-fortified matrix <50 ppb, 5 ppb >50 ppb, 10%	<50 ppb, 5 ppb >50 ppb, 10% RPD	NA

Analyte	Units	Expected Range (approx.)	Project Quant. Limit PQL	Analytical Method MDL	Achievable Laboratory MDL	Laboratory RDL, if provided	Accuracy (+/-)	Overall Precision (RPD or other)	Resolution
Total Nitrogen (TN) (USGS I-4650-03, alkaline persulfate digestion)	mg/l	0-1	0.10	0.015	0.020	0.060	80-120 % recovery for QC std. and lab fortified matrix	0.02 or 25% RPD	NA
Ammonia Nitrogen (NH3-N)	mg/L	0-0.5	0.02	Unknown	0.02	0.06	80-120% recovery for QC standard and lab fortified matrix	0.01 or 20% RPD	NA
Nitrate-Nitrite-N (NO3-NO2-N)	mg/l	0-1	0.02	Unknown	0.02	0.06	80-120 % recovery for QC std. and lab fortified matrix	0.02 or 25% RPD	NA
Total Kjeldahl Nitrogen (TKN)	mg/l	0-1	0.10	Unknown	0.10	0.30	80-120 % recovery for QC std. and lab fortified matrix	0.02 or 25% RPD	NA
Alkalinity	mg/l as CaCO3	Neg.-200	2	Unknown	2.0	2.0	80-120 % recovery for QC std. and lab fortified matrix <20, 2 mg/l >20, 10 %	2.0 or 20% RPD	NA
Hardness	mg/l as CaCO3	0-100	Unknown	Unknown	0.66	2.0	80-120 % recovery for QC std. and lab fortified matrix for Ca and Mg (200.7 method)	15 %	NA
Chloride	mg/l	0-100	Unknown	Unknown	1.0	1.0	90-110 % recovery for QC std. and lab fortified matrix	15 %	NA

Analyte	Units	Expected Range (approx.)	Project Quant. Limit PQL	Analytical Method MDL	Achievable Laboratory MDL	Laboratory RDL, if provided	Accuracy (+/-)	Overall Precision (RPD or other)	Resolution
BOD-5 and 21 day “ultimate” BOD	mg/l	0-15	Unknown	Unknown	2.0	6.0	80-120 % recovery for QC std.	20% RPD	NA
Color (lakes) (true & apparent)	PCU	0-300	NA	Unknown	10	10	80-120% of color standard <15 PCU (RDL) for blanks	<50, 10 PCU >50, 20% RPD	1 PCU
Chlorophyll *a* (lakes)	mg/m3	0-50	0.1	Unknown	0.1	0.1	75-125 % for QC std.	2.0 or 20% RPD	0.1
Turbidity (DWM lab)	NTU	1-150	NA	0.01 (est.)	0.2 (est.)	0.5 (est.)	1% of full scale (0-10) 5% full scale (0-100)	10%	0.01 NTU
E. coli , Enterococci bacteria (Colilert®, Enterolert®)	MPN/100 ml	0-2420 (max. with quanti-tray for un-diluted samples	1 MPN/ 100 ml	Unknown	1 MPN/100 ml	MPN of 1 /100 ml	Presence and/or >2420 MPN on positive control and absence and/or 0 (<RDL) for negative control	30% RPD for log 10 transformed duplicate data	NA
E. coli bacteria (modified MTEC MF)	cfu/100 ml	0-5000	5 cfu/100 ml	Unknown	5 cfu/100 ml	5 cfu/100 ml (WES lab)	“TNTC” on positive control and 0 or less than reporting limit for negative control	30% RPD for log 10 transformed duplicate data	NA
Fecal coliform bacteria (MF)	cfu/100 ml	0-5000	5 cfu/100 ml	Unknown	5 cfu/100 ml	5 cfu/100 ml (WES lab)	“TNTC” on positive control and 0 or less than reporting limit for negative control	30% RPD for log 10 transformed duplicate data	NA
Enterococci bacteria (MF)	cfu/100 ml	0-5000	5 cfu/100 ml	Unknown	5 cfu/100 ml	5 cfu/100 ml (WES lab)	“TNTC” on positive control and 0 or less than reporting limit for negative control	30% RPD for log 10 transformed duplicate data	NA

Analyte	Units	Expected Range (approx.)	Project Quant. Limit PQL	Analytical Method MDL	Achievable Laboratory MDL	Laboratory RDL, if provided	Accuracy (+/-)	Overall Precision (RPD or other)	Resolution
Detergents (DWM) (CHEMets kit)	mg/l linear alkyl-benzene sulfonate (eq. wgt. 325)	---	---	0.125	0.125	0.125	---	---	--- (0-3 mg/l range)
Fluorescent Whitening Agents (FWA) OB1 OB2 FWA1 FWA2 FWA4	ug/l	---	---	---	0.22 0.22 0.029 0.18 0.44	0.22 0.22 0.029 0.18 0.44	40-140% recovery for LFM and LFB	30% RSD	baseline separation of indiv. analytes
Optical Brighteners (DWM)	---	---	---	---	---	---	N.A.	N.A.	P/A
Secchi disc (lakes)	meters	0-5 m	NA	NA	NA	NA	NA	10 %	0.1 m
Lake Morphometry	meters	0-100 m	NA	NA	NA	NA	0.5 meter for indiv. datum	15% (est.) for indiv. datum	0.1 m
Macrophyte Percent Cover (lakes)	0-100%	NA	NA	NA	NA	NA	NA (if true % cover were known, results would be expected to be +/- 20%)	NA	NA
Macrophyte Identification	NA	NA	NA	NA	NA	NA	Qualitative assessment by aquatic plant experts in DWM via spot checking/testing the accuracy of identification using the same plants.	Qualitative assessment based on same-plant identifications by other survey crewmembers (see section 16)	NA
Habitat Assessment	NA	NA	NA	NA	NA	NA	NA	Qualitative evaluation based on duplicate assessment by other survey crewmembers.	NA

Analyte	Units	Expected Range (approx.)	Project Quant. Limit PQL	Analytical Method MDL	Achievable Laboratory MDL	Laboratory RDL, if provided	Accuracy (+/-)	Overall Precision (RPD or other)	Resolution
Benthic Macroinvertebrates (taxonomy)	NA	NA	NA	NA	NA	NA	Qualitative assessment based on spot checks for taxonomic accuracy using the same samples, by separate DWM macroinvertebrate experts.	Qualitative assessment based on same-sample identification by other taxonomists in the group (John Fiorentino and Bob Nuzzo)	NA
Fish Population	NA	NA	NA	NA	NA	NA	Qualitative assessment, based on in-field or lab specimen verification by other trained/expert DWM fish taxonomists (for fish type/species).	Qualitative and/or quantitative assessment based on replicate analysis of an adjacent reach by the same DWM taxonomists	NA
Fish Tissue Toxics									
-Length	mm	150-800	N/A	N/A	N/A	N/A	0.1	0.1	NA
-Weight (wet)	Grams	80-4000	N/A	N/A	N/A	N/A	20	20	NA
-Age	years	1-10	N/A	N/A	N/A	N/A	+/- 1	+/-1	NA
-Fish fillets (composites)									
Lipids	%	2-40	N/A	N/A	N/A	N/A	25%	30%	NA
Arsenic	ug/g wet	0-1	Unknown	Unknown	0.080	0.080	25%	30%	NA
Cadmium	ug/g wet	0-1	Unknown	Unknown	0.20	0.60	25%	30%	NA
Lead	ug/g wet	0-1	Unknown	Unknown	0.20	0.60	25%	30%	NA
Mercury	ug/g wet	0-5	0.5	Unknown	0.020	0.060	25%	30%	NA
Selenium	ug/g wet	0-1	Unknown	Unknown	0.20	0.60	25%	30%	NA
PCB Arochlor 1232	µg/g	0-5	1.0 (total)	Unknown	0.019	0.057	25%	30%	NA
PCB Arochlor 1242	µg/g	0-5	1.0 (total)	Unknown	0.019	0.057	25%	30%	NA
PCB Arochlor 1248	µg/g	0-5	1.0 (total)	Unknown	0.038	0.11	25%	30%	NA
PCB Arochlor 1254	µg/g	0-5	1.0 (total)	Unknown	0.013	0.039	25%	30%	NA
PCB Arochlor 1260	µg/g	0-5	1.0 (total)	Unknown	0.022	0.066	25%	30%	NA

Analyte	Units	Expected Range (approx.)	Project Quant. Limit PQL	Analytical Method MDL	Achievable Laboratory MDL	Laboratory RDL, if provided	Accuracy (+/-)	Overall Precision (RPD or other)	Resolution
Chlordane	µg/g	0-5	0.3	Unknown	0.046	0.14	25%	30%	NA
Toxaphene	µg/g	0-5	Unknown	Unknown	0.045	0.14	25%	30%	NA
a-BHC	µg/g	0-5	Unknown	Unknown	0.0054	0.016	25%	30%	NA
b-BHC	µg/g	0-5	Unknown	Unknown	0.0055	0.017	25%	30%	NA
Lindane	µg/g	0-5	Unknown	Unknown	0.0056	0.017	25%	30%	NA
d-BHC	µg/g	0-5	Unknown	Unknown	0.012	0.036	25%	30%	NA
Hexachlorocyclopentadiene	µg/g	0-5	Unknown	Unknown	0.038	0.11	25%	30%	NA
Hexachlorobenzene	µg/g	0-5	Unknown	Unknown	0.018	0.054	25%	30%	NA
Trifluralin	µg/g	0-5	Unknown	Unknown	0.032	0.096	25%	30%	NA
Heptachlor	µg/g	0-5	0.3	Unknown	0.0078	0.023	25%	30%	NA
Heptachlor Epoxide	µg/g	0-5	Unknown	Unknown	0.027	0.081	25%	30%	NA
Methoxychlor	µg/g	0-5	Unknown	Unknown	0.018	0.054	25%	30%	NA
DDD	µg/g	0-5	5.0 (total)	Unknown	0.0051	0.015	25%	30%	NA
DDE	µg/g	0-5	5.0 (total)	Unknown	0.0055	0.017	25%	30%	NA
DDT	µg/g	0-5	5.0 (total)	Unknown	0.0064	0.019	25%	30%	NA
Aldrin	µg/g	0-5	5.0 (total)	Unknown	0.0057	0.017	25%	30%	NA
PCNB	%	50-150	NA	NA	NA	NA	40%	NA	NA
PCB Congener BZ # 8	µg/g	0-0.02	Unknown	Unknown	0.0010	0.0030	25%	30%	NA
PCB Congener BZ # 18	µg/g	0-0.02	Unknown	Unknown	0.0016	0.0048	25%	30%	NA
PCB Congener BZ # 28	µg/g	0-0.02	Unknown	Unknown	0.0033	0.0099	25%	30%	NA
PCB Congener BZ # 44	µg/g	0-0.02	Unknown	Unknown	0.0010	0.0030	25%	30%	NA
PCB Congener BZ # 52	µg/g	0-0.02	Unknown	Unknown	0.0022	0.0066	25%	30%	NA
PCB Congener BZ # 101	µg/g	0-0.02	Unknown	Unknown	0.0022	0.0066	25%	30%	NA
PCB Congener BZ # 128	µg/g	0-0.02	Unknown	Unknown	0.0012	0.0036	25%	30%	NA
PCB Congener BZ # 138	µg/g	0-0.02	Unknown	Unknown	0.0017	0.0051	25%	30%	NA
PCB Congener BZ # 153	µg/g	0-0.02	Unknown	Unknown	0.0014	0.0042	25%	30%	NA
PCB Congener BZ # 187	µg/g	0-0.02	Unknown	Unknown	0.0022	0.0066	25%	30%	NA
PCB Congener BZ # 195	µg/g	0-0.02	Unknown	Unknown	0.0011	0.0033	25%	30%	NA

Analyte	Units	Expected Range (approx.)	Project Quant. Limit PQL	Analytical Method MDL	Achievable Laboratory MDL	Laboratory RDL, if provided	Accuracy (+/-)	Overall Precision (RPD or other)	Resolution
PCB Congener BZ # 206	µg/g	0-0.02	Unknown	Unknown	0.0012	0.0036	25%	30%	NA
PCB Congener BZ # 209	µg/g	0-0.02	Unknown	Unknown	0.0014	0.0042	25%	30%	NA
PCB Congener BZ # 81	µg/g	0-0.02	Unknown	Unknown	0.0010	0.0030	25%	30%	NA
PCB Congener BZ # 77	µg/g	0-0.02	Unknown	Unknown	0.0046	0.014	25%	30%	NA
PCB Congener BZ # 123	µg/g	0-0.02	Unknown	Unknown	0.0013	0.0039	25%	30%	NA
PCB Congener BZ # 118	µg/g	0-0.02	Unknown	Unknown	0.0012	0.0036	25%	30%	NA
PCB Congener BZ # 114	µg/g	0-0.02	Unknown	Unknown	0.0013	0.0039	25%	30%	NA
PCB Congener BZ # 105	µg/g	0-0.02	Unknown	Unknown	0.0013	0.0039	25%	30%	NA
PCB Congener BZ # 126	µg/g	0-0.02	Unknown	Unknown	0.001	0.003	25%	30%	NA
PCB Congener BZ # 167	µg/g	0-0.02	Unknown	Unknown	0.0012	0.0036	25%	30%	NA
PCB Congener BZ # 156	µg/g	0-0.02	Unknown	Unknown	0.0011	0.0033	25%	30%	NA
PCB Congener BZ # 157	µg/g	0-0.02	Unknown	Unknown	0.0012	0.0036	25%	30%	NA
PCB Congener BZ # 180	µg/g	0-0.02	Unknown	Unknown	0.0012	0.0036	25%	30%	NA
PCB Congener BZ # 169	µg/g	0-0.02	Unknown	Unknown	0.0006	0.0018	25%	30%	NA
PCB Congener BZ # 170	µg/g	0-0.02	Unknown	Unknown	0.0013	0.0039	25%	30%	NA
PCB Congener BZ # 189	µg/g	0-0.02	Unknown	Unknown	0.0013	0.0039	25%	30%	NA

Notes:

1) Accuracy and precision goals are based on potential error introduced via both field and lab activity. The analytical method limits are published in the analytical method and/or provided by the lab, as are the achievable laboratory limits. Multi-Probe information for accuracy and resolution is via manufacturer's specifications, and for precision is based on duplicate readings for lake sampling only.

2) "NA"= Not Applicable; "---"= no data

3) "Unknown"/"---" = no information available or no DQO defined at this time.

4) PCB/pesticide MDL/RDL values are based on most recent analyses by WES (2004), and as all DL values, subject to change

5) PAH analysis for fish tissue samples is not normally performed for DWM samples, and so DQO's for these are not presented here.

6) Detection limit information in Table 3 is based on the latest determinations by the WES and DWM labs, where DWM delivers most (and in some cases all) of its samples.

A8 TRAINING

Annual and as needed training in field and laboratory methods and procedures is provided to DWM staff (full time and seasonals) to ensure consistent and appropriate adherence to SOPs. The main focus of this training is to review the fundamentals of sample collection, associated documentation and specific lab protocols. Failure to follow and document basic, agreed-upon principles and procedures makes subsequent data use and analysis very difficult.

Table 4: DWM Training

Training	Description	Trainer(s)
CPR	Practice of CPR techniques to rescue victims	American Red Cross
Multi-probe Use	Discussion and practicum on how to use Hydrolab and YSI multi-probe units in the field to collect water quality data (single-use and deployment)	Jeff Smith, Richard Chase
Field Surveys	Discussion of survey preparation, procedures and special considerations	Richard Chase
Safety	Discussion of safety precautions both in the field and in the lab	Richard Chase
Flow	Discussion and practicum on proper preparation and performance of flow surveys, including use of velocity meters and data processing	Richard Chase, Brian Friedmann, Jeff Smith
Chlorophyll a	Analysis for chlorophyll a content in water samples	Joan Beskenis
Color	Analysis for apparent and true color of water samples in the lab	Mark Mattson, Richard Chase
Electrofishing surveys	How to perform electrofishing surveys safely and to minimize field error	Bob Maietta
E. coli by Colilert® (also Enterolert®)	Review of SOP for analysis at DWM lab	Richard Chase
Lab data reporting and data entry	Review of procedures for lab recordkeeping and data entry into DWM databases for field and lab data	Tom Dallaire, Richard Chase, Jane Ryder, misc. staff

NOTE: All training records are stored at DWM's QC office in Worcester, MA.

For each field monitoring survey event, the person serving as the survey crew leader (at a minimum) will have the following qualifications:

- Familiarity with this QAPP and all applicable SOPs for that survey
- Completion of a multiprobe sampling/grab sampling/QC training segment
- Prior field experience with survey equipment and with similar monitoring surveys

- Recent training in CPR/first aid by the American Red Cross (at least one certified person per survey)
- Be physically able to access the stations, carry equipment and samples, and perform the sampling.

All field survey crew personnel and WES/DWM lab personnel will be trained in the proper application of standard operating procedures (SOPs). Due to the manpower constraints explained above, the field training may range from formal DWM training sessions to field instructions provided by a trained and experienced DWM survey crew leader. All DWM training activity will be documented using signature sheets.

Specifically, the following DWM staff persons typically receive training as follows (may vary from year-to-year):

A8.1 **CPR** (annually, Spring-Summer):

- Richard Chase
- Laurie Kennedy
- Brian Friedmann
- Joan Beskenis
- John Fiorentino
- Russ Isaac
- Bob Maietta
- Jeff Smith
- Jane Ryder
- Susan Connors
- Elaine Hartman
- Alice Rojko
- Christine Duerring
- Kathleen Keohane
- Mark Mattson
- Gerry Szal
- Stella Tamul
- Bob Nuzzo
- Greg DeCesare (2005 only)
- Katie O'Brien-Clayton

A8.2 **Colilert® / Enterolert® (bacteria analysis at DWM Lab)***:* (annually, Summer)

- Richard Chase
- Joan Beskenis
- Jane Ryder
- Susan Connors
- Jeff Smith
- Christine Duerring
- Katie O'Brien-Clayton
- Stella Tamul
- Elaine Hartman
- 2-4 seasonal employees (as available, with supervision)

A8.3 **Multi-probe Use (including deployment)** (annually, Spring-Summer)

- Richard Chase
- Laurie Kennedy
- Brian Friedmann
- Joan Beskenis
- John Fiorentino
- Russ Isaac
- Bob Maietta
- Terry Beaudoin (CERO)
- Jeff Smith
- Jane Ryder
- Susan Connors
- Elaine Hartman
- Alice Rojko
- Christine Duerring
- Kathleen Keohane
- Warren Kimball (CERO)
- Mark Mattson
- Gerry Szal
- Stella Tamul
- Bob Nuzzo
- Greg DeCesare (2005 only)
- Katie O'Brien-Clayton
- All seasonal employees
- Malcolm Harper

A8.4 Field Surveys (including field & lab safety) (annually, Spring-Summer)

- Richard Chase
- Laurie Kennedy
- Brian Friedmann
- Joan Beskenis
- John Fiorentino
- Russ Isaac
- Bob Maietta
- Malcolm Harper
- Jeff Smith
- Jane Ryder
- Susan Connors
- Elaine Hartman
- Alice Rojko
- Christine Duerring
- Kathleen Keohane
- Terry Beaudoin (CERO)
- Mark Mattson
- Gerry Szal
- Stella Tamul
- Bob Nuzzo
- Greg DeCesare (2005 only)
- Katie O'Brien-Clayton
- All seasonal employees
- Warren Kimball (CERO)

A8.5 Chlorophyll a and Color (annually, Summer)

- Richard Chase
- Mark Mattson
- Joan Beskenis
- Jane Ryder
- 2-4 seasonal employees

A8.6 Flow (annually, Spring)

- Richard Chase
- Mark Mattson
- Bob Maietta
- Jeff Smith
- Elaine Hartman
- Susan Connors
- Brian Friedmann
- Kathleen Keohane

A9 DOCUMENTATION AND RECORDS

A9.1 Field Records

Field notebooks are optional for DWM surveys. These can be used based on individual staff preference to record detailed, additional information that is not contained on standard DWM fieldsheets. If used, copies of field notebook pages become part of the hard copy file for the project.

Observations made and measurements taken in the field are recorded on **standardized DWM Field Sheets.** DWM Fieldsheets are the main vehicle for recording field data. For most surveys, an individual field sheet is used for each station per sampling event. Currently (2005), there are ten types of fieldsheet forms in use:

- "Rivers & Streams"
- "Lakes & Ponds"
- "Pipes and Conduits"
- "Bacteria Source Tracking"
- "Multi-Probe Deployment"
- "Habitat Assessment Field Scoring"
- "Biomonitoring Field Data" (benthic surveys)
- "Fish Collection Data & Inventory" (fish tissue toxics)
- "Macrophyte Distibution Map" (blank template for each lake)
- "Fish Field Data" (fish population)

These forms are reviewed annually and updated as needed. Samples of selected completed DWM Field Sheets for water quality surveys can be found in Appendix I. Typical information required on the water quality field sheet forms includes, but is not limited to:

- Site name and watershed location
- Station Description
- Station Access Information
- Sample Name and ID #
- Personnel on-site performing the sampling
- Dates and times of sample collection
- Pertinent observations regarding uses (aquatic life, recreation, etc.)
- Summary of weather conditions
- Site observations and any aberrant sample handling comments
- Sample collection information (sample collection methods and devices, sample collection depth /heights, sample preservation information, matrix sampled, etc.).

Certain information that will not change can be pre-filled out prior to the survey to save time in the field. Other information is time-, location- and condition-specific, and should be filled out at the station ONLY. Each sheet must be filled out completely. Upon completion of the survey, each completed field sheet is submitted to the QA Analyst for hard copy filing.

In addition to paper records, use of digital cameras (and video as appropriate) is highly encouraged to document field activity, whether it be for reconnaissance or for sampling.

A9.2 Lab Records

Chain-of-Custody (COC) forms are used to transfer sample custody for all samples from DWM staff to lab staff. Both WES and contract lab forms are used. In some cases, DWM may use the WES COC form for non-WES lab samples (e.g., if contract lab COC form insufficient). See Appendix I for sample forms.

WES tracks samples via a Laboratory Information Management System (LIMS) and via paper hard copies to ensure protection of records and documents. In general, most hard copy data including logbooks, data analysis books, control charts, chain of custody forms, log-in sheets and data reports are archived for storage within a secure building. See the WES QA Plan for more information.

A9.3 Office Records

Formal DWM project folders containing field data, lab data and ancillary information are kept at DWM's offices in Worcester, MA. These records are maintained complete and orderly by all users via "folder rules", with oversight by the QA Analyst and Principle Investigator. They are physically housed in a dedicated file cabinet in the office of DWM's Database Manager.

A9.4 Document Tracking: "Control Numbers"

The DWM QC Analyst assigns document control numbers (CN) to all Quality Assurance Project Plans, SOPs, Assessment Reports and other important, internal documents. Assigning a control number ensures that the most current version is being used. A listing of all QAPP-, SOP- and Assessment Report-related documents is available in the QA/QC Document Control Number Logbook located in the QC Analyst's office and/or electronically in the Document Control Number Database.

A9.5 Sampling Station Registration

Prior to survey station visits for data collection, DWM's electronic station definition files are updated to include new, proposed stations. Each unique location (station) historically sampled has a "Unique ID" number and description.

A9.6 Documentation Protocols

DWM logbooks, forms, data sheets, lab notebooks and chain-of- custody forms are formal laboratory records. Records should be made in indelible black ink or extra fine point permanent marker. There should be no omissions in the data. Errors are kept to a minimum by exercising caution when recording and transcribing data. Erasing, "white-outs", removal of pages, and multiple crossovers are not used to correct errors. When errors do occur, they should be corrected according to the following procedures: 1) Draw a single line through the incorrect entry, insert the correct entry into the closest space available and initial and date the correction; 2) Groups of related errors on a single page should have one line through the entries and should be initialed and dated with a short comment supplied for the reason of data deletion.

Table 5 DWM Project Documentation and Records

Sample Collection Records	Field Analysis Records	Fixed Laboratory Records (WES and DWM)	Data Assessment Records
DWM Field Sheets	Multi-Probe Raw Data (Hard Copy & Electronic Copy)	Chain of Custody Forms	Data Validation Report for specific data sets
Field Notebooks	DWM Field Sheets	Laboratory Raw Data Reports and Notebooks	QA/QC discussion of data in published reports (e.g. Tech Memos)
Chain of Custody Forms	Multi-Probe Calibration Logbook	Electronic Laboratory Data (LIMS, EDD)	Watershed Assessment Reports
Digital photos	Multi-Probe Maintenance Logbook	Analytical Instrument Logbooks	Technical Correspondence (e.g., e-mail)
Survey-related Correspondence (e.g., e-mail)	Multi-Probe User Reports	Laboratory QC Results	Corrective Action Forms (CA)
		MDL Studies	Station definition files
		Reagent Water Logbook	
		Performance Evaluation Test Results	
		Incubator Temperature Log and other calibration logs	
		Accuracy Check Records for Continuous Temperature Loggers (DWM)	
		MSDS	
		Hazardous Waste Generation Forms and Waste Receipt Forms	

NOTE FOR SECTION B1:

SEE ALSO ANNUAL PROJECT-SPECIFIC SAMPLING & ANALYSIS PLANS (SAPs)

B1 SAMPLING PROCESS DESIGN

B1.1 Indicator Variables

DWM typically monitors specific core and supplemental indicators to assess the aquatic life uses, water contact recreational uses, and other human health-related water uses as defined in the Massachusetts Water Quality Standards (WQS), as indicated below. Data on these parameters are also used for other DEP/DWM information needs and programs.

Table 6: Core and Supplemental Indicators

INDICATOR TYPE	AQUATIC LIFE	RECREATION	FINFISH/SHELLFISH CONSUMPTION
Core	Macroinvertebrate community Fish community Periphyton/Phytoplankton Macrophyton Habitat quality * Flow Dissolved oxygen pH Temperature Turbidity Suspended solids Lake trophic status	Pathogens (e.g., *E. coli*) Transparency Algal blooms, (chlorophyll) Macrophyte density Land-use/% impervious cover	Mercury PCBs Pesticides Shellfish bed closures (non-management)
Supplemental	Toxic pollutants (e.g., metals) Toxicity tests (water, sediment) Tissue chemical assays Nutrients Chlorophyll Sediment chemistry Organism condition factor Non-native species Land-use/% impervious cover Fish kills Pollutant loadings	Aesthetics Objectionable deposits (scums, sheens, etc.) Flow/water level, Sediment quality Color/Turbidity pH	Other contaminants of concern Pathogens

* Water quantity (discharge), geomorphology (slope, bank stability, channel morphology), substrate (sediment type, embededness) and riparian zone (shoreline vegetation, canopy)

B1.2 Long-Term Design Strategy

Consistent with DEP's Water Quality Monitoring Strategy (DEP 2004), DWM monitoring is an integral component of a Statewide comprehensive monitoring program. Requirements for the monitoring program designed to support watershed assessments and TMDL development are that it be:

- statewide in scale
- comprehensive (all water bodies in the Commonwealth are assessed)
- repeated at regular intervals
- increase the number of stream miles and lake acres assessed, and
- reduce the historical bias toward problem areas

DWM is working to meet these goals within the next five years by planning to incorporate some probabilistic design elements into project sampling designs and add continuous, fixed-site monitoring to provide data pertaining to loads of contaminants carried by major river systems at strategic locations within Massachusetts. These elements would supplement DWM's existing targeted monitoring emphasis.

The ultimate long-term DEP strategy for Massachusetts proposes to utilize a combination of deterministically and probabilistically derived sampling networks, including synoptic surveys for the assessment of designated uses, fixed-station arrays for trend monitoring, intensive and screening-level targeted monitoring for various purposes, and statistical designs such as random sampling. These designs would encompass both rotating watershed monitoring cycles as well as non-rotating priority-driven schedules.

The strategy also includes significant efforts by the Department to enable two-way sharing of data. DWM monitoring data and information will be shared with other programs, both within the Department as well as in other agencies, for use in their work. In addition, data from external groups can also be used (based on case-by-case evaluations) to supplement information available to decision makers.

For more information on the proposed long-term strategy, see the "Strategy" document (DEP 2004).

B1.3 Current Conceptual Design Approach

The decision making process by DWM regarding where, when, how, why and what to sample is complex and difficult. The overall scope of the monitoring effort is limited by available human resources, equipment, funds and current priorities.

DWM's current monitoring focus is surface water quality, including streams, rivers, lakes, reservoirs, estuaries and coastal areas. The five-year rotating watershed assessment program is presently the primary means of meeting the CWA objective related to assessing the status of designated uses. During Year 1 of the rotating basin schedule all pertinent data and information relative to water resource management are gathered and reviewed to identify data gaps and the need for additional information. Input from outside agencies and the general public is actively solicited in order to gain further insight with respect to water quality goals and use-objectives.

This process culminates in the development of plans (project-specific Sampling & Analysis Plans) for obtaining this information during Year 2.

River and stream surveys are typically performed during low-flow, dry-weather conditions, which more closely approximate the worst-case scenario with respect to the potential for impairments. Due in part to the difficulties planning and implementing wet weather surveys, any wet weather data collected is usually unplanned.

Water quality surveys generally consist of five or six monthly sampling events from May through September. Typical analytes include pH, dissolved oxygen, temperature, conductivity, suspended solids, turbidity, color, nutrients (TP, TN, NH3-N), fecal coliform bacteria and *E. coli* bacteria. River surveys are sometimes supplemented by wastewater discharge sampling, which serves to document pollutant loading from point sources to the river at the time of the survey and to assess compliance with NPDES discharge permit limits. Stream discharge measurements may be made at selected stations to supplement data from the United States Geological Survey (USGS) stream gages. Discharge measurements provide data for the calculation of pollutant mass loadings, as well as for assessing the impacts on stream biota of low-flow conditions resulting from drought and/or water withdrawals. Additional site-specific data may also be collected for the development of water quality models. These data may include sediment oxygen demand, nutrient flux, and metal toxicity determinations. Lake surveys typically include such limnological measurements as chlorophyll a and Secchi depth.

The **biological monitoring** component in rivers typically consists of habitat assessments and surveys to collect macroinvertebrates, fish, aquatic plants and periphyton. These assessments help determine aquatic life use-support status.

The Rapid Bioassessment Protocols (RBPs), based on those developed by the EPA, are used to monitor the health of **benthic macroinvertebrate communities** in wadeable streams. These methods were developed to minimize laboratory time requirements for taxonomic identification and enumeration of benthos. Kick-net samples are collected at sites for upstream/downstream comparisons, for comparisons against a regional or surrogate reference, or for long-term trend monitoring. Two different levels of analysis are employed, RBP II or RBP III, depending on the objectives to be served. Based on scoring of several metrics, three categories of impairment are discerned by the RBP II (nonimpaired, moderately impaired, and severely impaired), while the RBP III distinguishes between four (nonimpaired, slightly impaired, moderately impaired, severely impaired). Benthic macroinvertebrate RBPs are conducted at up to 50 sampling sites per year.

The analysis of the structure and function of the finfish community as a measure of biological integrity is also a component of the water quality monitoring program. **Fish community** data quality and comparability are assured through the use of qualified fisheries professionals and the application of consistent methods. The Department utilizes a standardized method based on the EPA Rapid Bioassessment Protocol V (RBP V) to improve data comparability among wadeable sampling sites throughout the state. The fish collection procedures employ a multi-habitat approach that allows for sampling of habitats in relative proportion to their local availability. Electrofishing has generally proven to be the most comprehensive and effective *single* method for collecting stream fishes, and is, therefore, the preferred method for obtaining a representative sample of the fish community at each sampling site. Fish (except young-of-the-year) collected within the study reach are identified to species (or subspecies), counted, and examined for external anomalies (i.e., deformities, eroded fins, lesions, and tumors). Aquatic life use-support status is derived from knowledge of the environmental requirements (i.e., water temperature and clarity, dissolved oxygen content, etc.) and relative tolerance to water pollution of the fish species collected.

Algae represent a third community that is typically assessed as part of the biomonitoring efforts. The analysis of the attached algae or periphyton community in shallow streams or the phytoplankton in deeper rivers and lakes employs an indicator species approach whereby inferences on water quality conditions are drawn from an understanding of the environmental preferences and tolerances of the species present. Algal indicators of the presence of elevated metals concentrations, nutrient enrichment, or other pollutants are noted. Because the algal community typically exhibits dramatic temporal shifts in species composition throughout a single growing season, results from a single sampling event are generally not indicative of historical conditions. For this reason the information gained from the algal community assessment is more useful as a supplement to the assessments of other communities that serve to integrate conditions over a longer time period. In some instances, where information pertaining to primary production is required, algal biomass analysis or chlorophyll determinations may be performed. Results of these analyses are used to evaluate the trophic status of lakes, ponds, and impoundments. Similar information from riverine and coastal waters is used to identify those waterbodies subjected to excessive nutrient enrichment. Results at public drinking water reservoirs can indicate whether land uses need to be addressed as sources of nutrients and can help water suppliers adjust treatment processes if necessary.

Assays for the presence of **toxic contaminants in fish tissue** is another important DWM monitoring element. These data help assess the risk to human consumers associated with the consumption of freshwater finfish. In the past fish collection efforts were generally restricted to waterbodies where wastewater discharge data or previous water quality studies indicated potential toxic contamination problems. More recently concerns about mercury contamination from both local and far-field sources have led to a broader survey of waterbodies throughout Massachusetts. In both cases, the analyses have been restricted to edible fish fillets. This “Toxics-in-Fish” monitoring program is a cooperative effort of the Department of Environmental Protection, the Department of Fish and Game (DFG), and the Department of Public Health (DPH). Uniform protocols, designed to assure accuracy and prevent cross-contamination of samples, are followed for fish collection, processing and shipping. Fish are typically obtained with electrofishing gear or gill nets. Lengths and weights are measured and fish are visually examined for tumors, lesions, or other indications of disease. Data are provided to the DPH, which is the agency responsible for performing the risk assessments and issuing public health advisories. (Other tissue assays to trace the fate and transport of toxic contaminants in the aquatic environment are performed on a limited basis, primarily to support waste site clean-up activities)

Lake sampling consists of biological surveys of the macrophyton (i.e., aquatic vascular plants) community, "in-situ" measurements using metered probes, and limited water quality sampling to provide data for the calculation of TMDLs or the derivation of nutrient criteria. Lake surveys are generally conducted on multiple days for TMDL development and consist of bathymetric mapping; physical, chemical and biological sampling of the open water areas, tributary stream(s), and outlet; and a quantitative and qualitative mapping of the aquatic macrophyton community. The lake is sampled during the summer months when productivity is high. Some limited use assessments may be accomplished through the lake monitoring described above depending upon the scope of the individual lake surveys. Cover estimates and species distribution of macrophytes, and measurements of water column transparency support a limited assessment of the recreational uses. Finally, macrophyte surveys are used to document the spread of several non-native and potentially nuisance aquatic plant species that are known to be present in Massachusetts.

Because bacterial contamination is one of the leading causes of impairment in Massachusetts waters, special consideration has recently been given to **locating sources of bacterial contamination** of waterways, and then working with regional and local parties on potential corrective actions. In order to efficiently and correctly track down the likely source(s), DWM has formulated and tested field and lab protocols. Conceptually, the "toolbox" approach is used to:

- Identify and prioritize contaminated subwatershed(s) for locating sources;
- Characterize the priority subwatershed(s);
- Design and carry out screening-level sampling; and
- Evaluate screening level data and design and perform source location monitoring.

This targeted monitoring design includes the use of GIS land-use coverages, other overlays, and color ortho photos to identify potential sources, and the use of both dry weather and wet weather sampling to determine the contribution of stormwater runoff to the bacterial content of surface waters. The monitoring design employs an iterative sampling process that involves the adjustment of sampling site locations in response to a timely review of previous results in an effort to narrow down the exact location of the bacteria sources. The sampling includes the bracketing of suspected point sources (e.g., pipes, ditches, culverts) and non-point sources (e.g., specific land-use types, small tributaries, neighborhoods). Sampling stations also include base stations established during screening level sampling to document and track reference conditions.

A key element of this project is the capacity to analyze a large number of samples while maintaining rapid turn-around time between the collection of those samples and the availability of the analytical results. This is essential for the determination of how to proceed with subsequent sampling. To this end, the Department purchased and installed the IDEXX, Inc. Colilert® and Enterolert® testing systems at its laboratory facility in Worcester. Use of this EPA-approved technology will lessen the burden placed on the Department's Wall Experiment Station for bacterial analyses and decrease sample delivery time.

Sampling results, associated subwatershed information, and local input are used to identify sources of bacteria contamination to the extent of the Department jurisdictional authority, at a minimum. Appropriate authorities are then notified of the suspected source(s) and recommendations for further source tracking work (e.g., for likely illicit discharges to storm sewer), clean-up, or enforcement action may be made. See Appendix H for more information on bacteria source tracking.

Special project monitoring is also sometimes performed by DWM due to priority issues of concern, subject to staff availability and other resources. These surveys are usually planned on a "fast track" but with the same attention to quality work in the field and in the lab.

B1.4 Detailed Project-Specific Sampling Designs

For details regarding project-specific sampling locations, frequencies, analytes, methods, etc., see the separate and individual **Sampling & Analysis Plans (SAPs).** The annual SAPs are supplements to this programmatic QAPP, and their contents mirror selected QA-R5 Guidance elements (i.e., A4-A6, B1, and B9) as they pertain to those projects. The SAPs are contained on the accompanying QAPP CD and submitted to EPA-NE for approval.

DWM monitoring as detailed in project-specific SAPs generally have the following characteristics:

- The schedule of all sampling surveys for lakes and rivers (water quality, biomonitoring, fish toxics, aquatic habitat, fish population and fish toxics) is intentionally biased to occur within the primary contact season of April 1-October 15.

- Water quality parameters typically include but are not limited to dissolved oxygen, temperature, pH, conductivity, indicator bacteria (e.g., *E. coli*, Enterococci), nutrients (e.g., phosphorus, ammonia-nitrogen), turbidity and total suspended solids. Other monitoring includes fish community sampling, aquatic plant surveys, benthic macroinvertebrate monitoring, aquatic habitat assessment, and fish tissue contaminant testing.

- Decisions regarding where to sample, what to sample for, and when to sample have unavoidable trade-offs. Prioritizations based on location (e.g., previously unassessed vs. re-assessed), parameter and frequency are made following extensive coordination within DEP and with outside groups (volunteer groups, regional DEP offices, other agencies, etc.). Decisions regarding total number of samples and analytes are made in coordination with the Wall Experiment Station (WES) and other labs, as applicable.

- Perceived “hot spot” locations and reference sites are targeted for periodic (typically monthly), synoptic monitoring (non-probabilistic design), with water sample collection typically done using grab sampling techniques. Inferences are often made that the observed water quality conditions for certain parameters at the time of the individual sampling survey(s) provide a reasonable picture of typical water quality conditions at those sites over an undetermined, wider bracket of time.

- Biological monitoring of benthic macroinvertebrates, aquatic plants, periphyton and fish assemblages is an integral component of DWM’s approach to 305(b) assessments and TMDLs. To provide information necessary for making basin-wide aquatic life use designations required by Section 305(b) of the CWA, benthic macroinvertebrate data are compared to regional reference stations. Use of regional reference stations is particularly useful in assessing pollution impacts (e.g., physical habitat degradation), including nonpoint source pollution at upstream control sites as well as suspected chemically impacted sites downstream from known point source stressors. (Some stations may not be compared to a regional reference station due to significant differences in stream morphology, flow regimes, and drainage area, or simply lack of a suitable reference site.)

- While most sampling events are intended to be “dry weather surveys” (lack of precipitation 48-72 hours prior to survey), unplanned “wet weather surveys” (antecedent precipitation sufficient to cause a significant increase in streamflow) can also occur.

- Lake and pond sampling by DWM is intended to provide water quality information to support TMDL development and support 305(b) assessments. Resulting, quality-controlled data are often assumed to reasonably represent typical lake conditions during late summer stratification (resulting in increased impairment). Water quality parameters are primarily due to eutrophication/ nutrient issues (total phosphorus, chlorophyll a, plants).

B2 SAMPLING METHODS

B2.1 DWM Field SOPs

All DWM field sampling follows the most current and approved DWM Standard Operating Procedures (SOPs), as listed in Table 7, along with applicable references used to help formulate them.

Also, see Appendix H for a description of DWM's "toolbox" approach for tracking bacteria sources.

Table 7: DWM Field Method SOPs

Control Number(s)	SOP	Applicable "Standard" Method Reference(s)
CN 1.21	Sample collection	- USGS TWRI Book 9 (1998) - Standard Methods
CN 4.21	Multiprobe use	Hydrolab and YSI manuals
CN 4.4	Multiprobe deployment	Hydrolab and YSI manuals
CN 39.2	Benthic macroinvertebrate/Habitat	- Modified RBP (EPA) - USGS TWRI Book 5 (1987)
CN 40.1	Fish collection/preparation for fish tissue analysis	- EPA guidance for fish sampling and analysis for fish advisories (1995) - USGS TWRI Book 5 (1987)
CN 55.0	Secchi transparency	EPA Volunteer Lake Monitoring methods manual (1991)
CN 58.0	Optical brighteners	---
CN 60.0	Periphyton	- Modified RBP (EPA) - USGS TWRI Book 5 (1987)
CN 67.1	Macrophyte survey mapping	- USGS TWRI Book 5 (1987) - EPA Volunteer Lake Monitoring methods manual (1991)
CN 68.0-68.6	Flow monitoring SOP, quickguides	- USGS TWRI Book 3 - Sontek, Swoffer manuals
CN 75.1	Fish Population	- Modified RBP (EPA) - USGS TWRI Book 5 (1987)
CN 82.1	Bathymetric mapping	Lowrance LMS-240 manual
CN 103.0	Continuous temperature monitoring	- Onset Stowaway® manual - SM 2550 (2000)
CN 200.0	Digital camera use	Kodak and Olympus camera manuals
CN 210.0	Mobile phone use	Verizon cell phone manual ,contract
CN 230.0	Algal Toxins (pending)	---

B2.2 Field Safety

The survey coordinators and crewmembers shall use best professional judgment (BPJ) at all times, and at no time allow personal safety to be compromised. In addition, all survey personnel are trained in field safety issues, including what to do in the event of an emergency. **<u>The "SAFETY FIRST" principle shall be adhered to at all times</u>.**

A "standard-issue" <u>Field Kit</u> shall be brought on each field survey. These kits include miscellaneous items often needed in the field, such as plastic gloves, safety glasses, sunscreen, insect repellant, ivy wash, etc.

A complete <u>First Aid Kit</u> containing basic first aid equipment shall be brought (in the vehicle) on each field survey. In situations where sampling stations are far from the vehicle, crews have been instructed to take the first aid kit to the station.

At least one member of the survey team shall be trained in cardiopulmonary resuscitation (CPR) and basic first aid procedures. An Adult CPR Review training course is held annually at DWM's Worcester office.

Each crewmember is expected to dress appropriately for the season, weather and field conditions, especially proper footwear and raingear. Each crewmember has also been advised to wear orange, reflective safety vests at all times during a survey, especially when sampling in high vehicular traffic areas. These vests are available at DWM, Worcester. To assist crews in preparation, a survey trip checklist and field kit checklist is used.

DWM cellular phones are also available and should be brought on every survey for emergency use as well as field coordination as necessary. In lieu of departmental phones, personal cellular phones can be used when necessary.

B2.3 Available Field Equipment

A partial list of the more important field items for use by DWM staff is as follows:

Table 8: DWM Field Equipment (primary)

Equipment or Service	2005 Inventory	CN # reference	Comments
Cell phones	6	CN 210	---
Digital cameras	2	CN 200	---
Bottle baskets	6	CN 1.21	For bridge drops
QC/PT audit samples	2-4 tests	---	QC/PT samples for NUTS (TP, TN, NH3, etc.), m-FC, *E. coli* (+/-)
Flow meters	4 kits	CN 68.0	---
Staff gages	~45	CN 68.0	Each 3 feet long
Dye testing	available	CN 68.0	For time-of-travel, mixing zone studies, etc.

Equipment or Service	2005 Inventory	CN # reference	Comments
Continuous temperature probes	16	CN 103.0	---
NIST-certified thermometer (Digi-Sense)	1	CN 103.0	---
Hip chain	1	---	---
Densiometers	2	---	Canopy cover measurement using these hand-held devices not yet standardized for DWM use.
Rangefinders	3	---	---
Portable peristaltic pump	1	CN 1.21	For use in hard-to-sample areas, for field-filtration, etc.
GPS	3	---	Use of these devices for DWM survey data collection not yet standardized.
ISCO auto-samplers	8-10	---	---
Apparent/true Color testing	2 color wheels	CN 2.2	---
Chlorophyll a testing	available	CN 3.4	---
Portable turbidimeter	1	CN 95.1	Mainly for in-lab use at DWM
Colilert® / Enterolert®	available	CN 198.0	---
Fluorometer (bacteria source tracking)	1	----	For in-lab use only; testing on-going; SOP may be developed
misc. test kits (e.g., detergents, hardness)	---	---	follow manufacturer's instructions
Smoke testing unit	1	----	Liquid smoke for unit also available
Sediment samplers	available	----	SOP pending
Van Dorn bottle samplers	4-6	CN 1.21	Certain bottles are preferred over others due to historical TP in equipment blanks issue. Check with M. Mattson or R. Chase
Sonar depth sounder	2	CN 82.1	---
DO probe (single)	2	CN 4.21	---
SCT probe	3	CN 4.21	---
pH probe (single)	2	CN 4.21	---
Multi-probe loggers for unattended deployment	12	CN 4.4	DO/T only
4-parameter multi-probes	8-10	CN 4.21	Some can also be used as unattended data loggers
WQ contract labs	2 contracts (2005)	----	Berkshire Enviro Labs, Lee, MA Envirotech Labs, Sandwich, MA (2005-06 with option for renewal)

B2.4 Bottle Groups, Types and Preservatives for Typical Analytes

Bottle group designations, associated parameters, and bottle type and preservative requirements for water and tissue sample analytes are shown in Table 9.

B2.5 Sample "OWMID #" Allocations

Individual sample identification numbers are allocated by DWM's Database Manager, as described below. A season's worth of laser-printed OWMID # labels is provided to each project Principle Investigator for use on the fieldsheet forms.

- **Lake surveys:** One ID label is physically affixed on the fieldsheet in the top corner of pg.2 and control up to 10 samples IDs, where the last digit is filled in by the survey lead (e.g., LC - 435_) for each separate sample (with "0" always being the multi-probe ID).

- **Rivers and all other surveys:** Six digit ID (e.g., 36-2105) labels are affixed on the fieldsheets for each separate sample.

B2.6 Field Quality Control (see B5)

B2.7 Field Documentation (see A9)

Table 9: Bottle Group, Bottle Type and Field Preservation Methods for DWM Samples *

ANALYTE GROUP		PARAMETERS	BOTTLE TYPE **	PRESERVATIVE ***
Chemistry	C	Alkalinity, chloride, hardness, specific conductance, turbidity, color	HDPE (500-1000 mls)	1:1 HNO_3 to pH < 2 (hardness only)
Nutrient	N	Total phosphorus, soluble phosphorus fractions, total nitrogen, ammonia nitrogen, nitrate-nitrite nitrogen	HDPE (500-1000 mls)	H_2SO_4 (9-18 N, 2-3 mls.) to pH < 2
Solids	S	Total suspended solids, total solids, total dissolved solids	HDPE (1000 mls)	---
Bacteria	B	Fecal coliform, *E. coli,* Enterococci, and including Bacteroidetes and Enterococcus faecium human marker analyses	Sterile, sealed plastic (120-250 mls)	Sodium thiosulfate for dechlorination (as needed)
Algae	A	Chlorophyll a, phytoplankton	HDPE (500-1000 mls)	---
FWA	FWA	Fluorescent Whitening Agents	Amber glass (500 mls)	---
Toxicity	TOX	various toxicity end points, whole effluent toxicity	PE	---
Metals	M	Hg, As, Cd, Cr, Pb, Se, Zn, Fe, Ni, etc.	HDPE (500 mls)	1:1 HNO_3 to pH < 2
Oxygen Demand	OXD	BOD, COD	Glass “BOD” bottles (300 ml with glass stopper)	1:1 H_2SO_4 to pH < 2 (COD only)
Volatile Organics	VOC	Numerous	Glass with Teflon-lined septum caps (40 mls)	1:1 HCL (no headspace)
Hydrocarbons	H	Oil and grease, total petroleum hydrocarbons, numerous poly-aromatic hydrocarbons	Amber glass (1000 mls)	1:1 H_2SO_4 to pH < 2
PCBs and Pesticides (fish)	PCB	Numerous	NA	---
Extractable Organics	EOC	Numerous	Amber glass (1000 mls)	---

* For any given analyte, bottle type and preservative recipe are generally independent of analytical method. Differences in required preservative within a bottle group are addressed on a case-by case basis.

** In all cases, new, pre-cleaned bottles are used.

*** Wet ice to < 6 deg. C in dark cooler is standard short-term storage for all samples for all samples

B3 SAMPLE HANDLING AND TRACKING

B3.1 Assignment of LOCATION ID#s (Station ID and Unique ID)

Prior to each survey, the Survey Coordinator must verify that each station to be visited has been given the following two location-specific IDs: 1) Station ID# (e.g., BB01) and more importantly, 2) Unique ID# (e.g., W0657).

The Unique ID is provided by the DWM Database Manager. Both ID numbers are used on the station-specific DWM fieldsheets. If unplanned station visits occur for which Station ID/Unique ID was not provided, the Survey Coordinator shall get both immediately following the survey from the Database Manager, and insert the IDs onto the appropriate fieldsheet.

B3.2 Assignment of SAMPLE ID#s ("OWMID" #)

See B2.5. The Database Manager provides each Survey Coordinator with Sample ID# or "OWMID"s. The Survey Coordinators are responsible for avoiding use of duplicate OWMIDs. NOTE: Multi-probe data at each stations also get separate Sample IDs.

B3.3 Sample Bottle Labeling

An example of the required container label displaying the OWMIDs is shown in Appendix I. As part of survey preparation, bottle labels shall be filled out and affixed to bottles prior to bottles getting wet (i.e., used and/or placed in coolers).

B3.4 Sample Preservation/Transport

All samples taken are preserved in coolers using wet ice to <6 deg. C. until delivered to the lab. Bacteria samples transported in coolers are kept in plastic bags immersed in ice to keep them dry. Nutrient (e.g., TP, TN, NH3-N, NO3-NO2-N) samples are preserved with sulfuric acid (9-18N) immediately after collection.

All bacteria samples are delivered to the appropriate lab(s) for analysis ASAP and within 6 hours of collection. Typically, bacteria sample bottles contain sodium thiosulfate for dechlorination, in case of residual chlorine. (The presence of residual chlorine is site-specific; lack of sodium thiosulfate in sample bottles is only allowed when there is no possibility of residual chlorine being present at each location.)

Most samples are typically delivered to the State laboratory, Wall Experiment Station (WES) in Lawrence, Ma. or one or more contract labs for analysis. Samples for color, chlorophyll a, plants, benthic macroinvertebrates and *E.coli* and/or Enterococci by Colilert® / Enterolert® are delivered to the DWM lab in Worcester, MA. Sample for turbidity are taken either to WES, a contract lab or DWM. If samples are delivered by a person(s) that was not involved in taking the sample, the COC form will be filled out and signed off during the transfer.

B3.5 Sample Preparation for Analysis

Depending on the analyte, samples may need to be prepared for later analysis by others (e.g., filleting fish for tissue samples) or just prior to analysis (e.g., true color, chlorophyll a). For water samples, this usually involves filtration to remove suspended solids (e.g., via 0.45u filter).

B3.6 Chain-of-Custody (COC) Forms

Standard Chain-of-Custody (COC) forms will be used to transfer sample custody from DWM staff to the WES, DWM or other lab as appropriate. See Appendix I for sample forms.

The proper procedure for filling out a COC form and transferring sample custody is documented in the respective laboratory Quality Assurance Plans, and in this QAPP. A copy of the WES SOP for filling out the COC form is posted in the DWM-Worcester lab.

COC users should remember to:

- Sign into/out of the fridge when samples are kept temporarily in cold storage (<6 deg. C) at the DWM lab prior to delivery to the lab.
- Fill out the Sample Field ID (OWMID#), Site Name (e.g., PB01) and sample-specific dates/times for all samples.
- Leave the Field Locator column BLANK.
- List the MADEP Division always, specifically and consistently as "DWM-WP".
- List the Project Name consistently
- Be specific in the Analysis Requested column; include analyte (and specific method if appropriate).
- Always use sample preservation codes.
- Get a copy of the signed COC (with Lab login ID) prior to leaving the lab.

When field samples arrive at the lab, the DWM staff relinquishes custody of samples to the laboratory staff. The sample containers are then removed from the shipping or transportation cooler and visually inspected for damage such as leakage, breakage, or contamination. The samples received are then compared with accompanying custody and analysis specification forms to make sure that the paperwork agrees with the labels on each sample container. All individuals who handle samples are required to sign and date the COC forms. Once completed and signed by all involved in the transaction, the lab shall provide a copy of the completed form to the sample delivery crew or person. After samples have been officially transferred and assigned laboratory identification numbers, they are stored, distributed and analyzed according to the lab's SOPs.

B3.6 Lab Sample Tracking

The Wall Experiment Station (WES) tracks samples via a Laboratory Information Management System (LIMS). The DWM labs use lab notebooks and standardized lab data reports to keep track of samples. DWM ensures that similar mechanisms are in place for any contract labs it employs.

B4 ANALYTICAL METHODS

All DWM samples are analyzed using standard protocols contained in accepted WES, DWM or other laboratory SOPs. Analyses are consistent with each lab's laboratory Quality Assurance Plan and Lab Safety Plan. See QAPP CD for specific lab SOPs.

B4.1 DWM Lab SOPs

All DWM lab work follows the most current and approved Standard Operating Procedures (SOPs), as follows.

Table 10: DWM Lab Method SOPs

Control Number	SOP
CN 0.3	DWM lab safety
CN 0.4	DWM lab data reporting
CN 2.2	Color analysis (DWM)
CN 3.4	Chlorophyll *a* analysis (DWM)
CN 39.2	Benthic macroinvertebrate analysis
CN 95.1	Turbidity analysis (DWM)
CN 198.0	Colilert® (and Enterolert®) bacteria analysis (DWM)
CN 230.0	Algal toxins (DWM, pending)

B4.2 WES (and other) Lab SOPs

WES and contract lab procedures follow their most current and approved Standard Operating Procedures (SOPs), as follows. See QAPP CD for specific WES SOPs.

Table 11: WES and Contract Lab Method SOPs (for common DWM analytes)

Reference #	SOP
Various	WES Lab SOPs for fecal coliform, *E. coli* bacteria, Enterococci bacteria, TP, dissolved P forms, NH3-N, TN, TKN, NO3-NO2-N, TSS, alkalinity, hardness, turbidity, fluorescent whitening agents, total/dissolved metals, PCB arochlors and congeners, organochlorine pesticides, etc.
TBD	Misc. contract lab SOPs as applicable. Typically, for fecal coliform and *E. coli* (and others if needed)

B4.3 Analytical Methods, Units and Holding Times

The methods and associated holding times for common DWM parameters are provided below primarily for the WES and DWM labs, but also as historically provided by contract labs employed by DWM. DWM ensures that identical (or similar) established methods are employed by all contract labs in order to be able to compare data from different labs.

Detection limits using these methods can vary within labs (temporally) and among different labs. For detection limit information, see Table 3 (Element A7).

Table 12: Analytical Methods and Holding Times for typical DWM Samples

PARAMETER	UNITS	METHOD(S)	HOLDING TIME (DAYS)
Chloride	mg/L	SM 4500-CL-(B)	28
Alkalinity	mg/L	SM 2320	14
Color (apparent and true)	PCU	SM 2120-B	2
Hardness (Ca + Mg)	mg/L	SM 2340 (EPA 200.7)	180
Turbidity	NTU	EPA 180.1	2
Turbidity	NTU	SM 2130-B	2
Total Suspended Solids	mg/L	SM 2540-D	7
Total Suspended Solids	mg/L	EPA 160.2	7
E. coli - Modified m-TEC	CFU/100mL	EPA 1603	6 hours (delivery) plus 2 hours (lab)
E. coli - MTEC	CFU/100mL	SM 9213-D	6 hours (delivery) plus 2 hours (lab)
E. coli - MF	CFU/100mL	EPA 1103_1	6 hours (delivery) plus 2 hours (lab)
E. coli – “Colilert”	MPN/100mL	SM 9223-B	6 hours (delivery) plus 2 hours (lab)
Fecal Coliforms	CFU/100mL	SM 9222-D	6 hours (delivery) plus 2 hours (lab)
Enterococci	CFU/100mL	EPA 1600	6 hours (delivery) plus 2 hours (lab)
Total Nitrogen	mg/L	USGS I-4650-03	28
Kjeldahl-N	mg/L	EPA 351.2	28
Nitrate/Nitrite-N	mg/L	EPA 353.1	28
Ammonia-N	mg/L	EPA 350.1	28
Ammonia-N	mg/L	LACHAT 10-107-06-1-B	28
Ammonia-N	mg/L	ASTM D6919-03	28
Ammonia-N	mg/L	SM 4500-NH3-B,C	28
Dissolved Reactive Phosphorus (DRP)	mg/L	SM 4500-P-A,B1,E	2

PARAMETER	UNITS	METHOD(S)	HOLDING TIME (DAYS)
Total Dissolved Phosphorus (TDP)	mg/L	SM 4500-P-E	2
Total Reactive Phosphorus (TRP)	mg/L	SM 4500-P-E	2
Total Phosphorus	mg/L	SM 4500-P-E	28
Chlorophyll a	mg/m3	EPA 445	1 (sample) 21 (frozen filter)
OB-1	ug/L	"FWA" (WES)	7
OB-2	ug/L	"FWA" (WES)	7
FWA-4	ug/L	"FWA" (WES)	7
FWA-1	ug/L	"FWA" (WES)	7
FWA-2	ug/L	"FWA" (WES)	7
Toxicity	Variable *	Various * (e.g., "chronic Microtox")	Variable * (ASAP)
Metals (e.g., Hg, As, Cd, Cr, Pb, Se, Zn, Fe, Ni)	ug/L	EPA 200.7, 200.8, 200.9 and 245.1	28 (Hg) 180 (others)
BOD	mg/l	SM 5210 B	1
COD	mg/l	SM 5220	1
Volatile organics	ug/L	EPA 624	14
Oil and grease, total petroleum hydrocarbons, numerous poly-aromatic hydrocarbons	ug/l	SM 5520D, (O&G) EPA 625	28 (O&G)
PCBs and Pesticides (fish)	ug/g	Modified AOAC 983.21	7 (extraction) 40 (analysis)
Extractable Organics	ug/L	SM 5520	7 (extraction) 40 (analysis)

* NOTE: DWM and WES are currently evaluating alternative "ambient toxicity" tests. The Microtox method has not been employed for several years, due to both analytical and logistical issues. Typical units are IC 50, LOEC and NOEC.

B4.4 Data Reporting

All WES, DWM and other lab's quality-controlled data is sent to DWM's QA Analyst and Database Manager for preliminary QC checks. This includes electronic (WES and contract lab EDDs as available) and hard copy (WES, DWM, other) data reports.

For WES data transmittals, WES forwards data extracts of final/near final data from their LIMS to DWM for review on an approximate monthly basis. Each successive data transfer overwrites the last. The final data transfer in the fall-winter represents the final lab data set. In addition to electronic data, WES continues to send hard copy (.snp or .pdf format) files to DWM as they become finalized at WES.

Following preliminary DWM QC review for completeness and typographic-type errors, lab data can be released to the survey coordinators and others as "raw" data (QC status 1).

B4.5 Lab Data Qualifiers

The WES lab makes every effort to avoid the use of data qualifiers through sound lab practices, such as efficient sample tracking, expedient analysis and re-testing. In some instances, however, qualification of data is necessary and, in all cases, helpful when needed. The WES LIMS may use the following standard data qualifiers/text results for DWM analytes:

WES LIMS Qualifiers:

- "**B**" = Analyte found in reagant blank
- "**H**" = Analytical holding time exceeded.
- "**M**" = MDL < sample concentration < RDL (estimated value, when reporting values down to the MDL)
- "**<RDL**" = MDL < sample concentration < RDL (when NOT reporting values down to the MDL)
- "**ND**" = Analyte not detected above MDL (i.e., < MDL)
- "**J**" = misc. QC criteria not met
- "**R**" = Sample results rejected; re-analysis warranted.

For consistency, the DWM labs and database will employ the following (mostly the same) standard lab qualifiers/text results for DWM lab analytes (color, chlorophyll a, turbidity and *E. coli)* when needed for problematic data:

DWM Lab Qualifiers:

- "**B**" = Analyte found in reagant blank
- "**H**" = Analytical holding time exceeded.
- "**J**" = misc. QC criteria not met
- "**<RDL**" = sample concentration < RDL
- "**<MDL**" = sample concentration < MDL
- "**>UQL**" = sample concentration > upper quantitation limit
- ****** = missing result
- ## = censored data

For contract labs employed by DWM, the use of data qualifiers varies. Whenever possible, DWM asks these labs to utilize a set of data qualifiers similar to that used by WES and/or DWM.

B5 QUALITY CONTROL

B5.1 Field Quality Control (QC Samples, Training and Audits)

See Tables 13-15 for quality control requirements for water quality analytes, multiprobe parameters (including continuous deployment) and for continuous temperature sensors, respectively.

Field sample replication for estimating overall precision is through the taking of **co-located, simultaneous, duplicate** grab samples at approx. 10% of the total number of samples and a minimum of one per survey per analyte group.

In addition, **ambient field blanks** are taken at 10% of total samples to evaluate blank contamination from field activities.

Training sessions for DWM survey crew staff are held in Spring, Year 2 prior to any field surveys, to ensure that field measurements and samples will be taken consistent with accepted, approved DWM SOPs. In addition, field checks or audits are performed by DWM's QC Analyst to ensure consistent application of field protocols among different field crews.

B5.2 Lab Quality Control

Required lab quality control procedures include detailed recordkeeping, current SOPs, performance evaluation samples, lab blank, duplicate and matrix spike analyses, and control and calibration charts. For detailed descriptions of calibration and maintenance procedures for WES and other labs, see the applicable lab QAPs and SOPs, adopted herein by reference.

DWM requests quality control data from all labs with submitted data packages. These data are used in data validation.

B5.3 Special QC Studies

Special quality control studies are typically performed by DWM's QA Analyst with assistance from staff. An example of planned studies for 2005-06 is provided in Table 16.

Table 13 Field Sampling Quality Control Requirements for *Water Quality Analytes* (e.g. TP, *E. coli* bacteria, Chlorophyll a, etc.)

	Frequency	Corrective Action	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Ambient Field Blanks	Minimum 10% of samples collected, and a minimum of 1 per event	Qualify or censor data as necessary	Survey Coordinator and QC Analyst	Accuracy (contamination)	No target analytes exceeding MDL
Field Duplicates	Minimum 10% of samples collected, and a minimum of 1 per event	Evaluate and compare lab dups and field dups (overall precision) Censor or qualify data as necessary	Survey Coordinator and DWM QC Analyst	Overall Precision	See Table 3
Performance Evaluation Sample (PES)	One time delivery to WES Lab for nutrients. One time delivery to DWM Lab for bacteria.	Discuss with lab; rerun test samples Censor or qualify data as necessary	DWM QC Analyst and lab QC officer, as appropriate	Accuracy	Same as QC/PT sample acceptance criteria (provided by PT lab)
Cooler Temperature Blank	Each cooler	Add more ice; drain cooler water	Survey crew leader	Accuracy (preservation)	0-6 deg. C

Table 14 Quality Control Requirements for *Multi-Probe Instruments* (D.O., pH, Conductivity, Temperature, depth)

	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Pre-Calibration (or pre-deployment)	Each day used	See SOP (CN 4.21) and Multi-Probe Manual(s)	Re-calibrate to within allowable specs.	Multi-Probe Coordinator & QC Analyst	Accuracy/bias Contamination	Must meet or exceed instrument accuracy specs (see Table 9)
Field Duplicate reading (Lakes only)	10% of sites	RPD < 10%	Re-deploy and start reading sequence again	Field survey crew leader	General precision	RPD < 10%
Instrument Blank	After Pre & Post Daily Calibration	No target compounds> lowest calibration standard	Retest and/or qualify data	Multi-Probe Coordinator & QC Analyst	Accuracy/bias Contamination	No target compounds> lowest calibration level
Post-Survey (or post-deployment) Check and User Report	End of each day or after deployment	See SOP (CN 4.21) and Multi-Probe Manual(s)	If outside acceptance limits, discard or qualify data	Multi-Probe Coordinator & QC Analyst	Accuracy/bias Contamination	Must meet or exceed instrument accuracy specs (see Table 3)

Table 15 Quality Control Requirements for *Continuous Temperature Loggers*

	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Persons Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Pre-Deployment QC Check	Before every use for each sensor	+/- 0.2 deg. C	Replace with more accurate sensor	Project Coordinator & QC Analyst	Accuracy (temperature and time) compared against NIST-traceable thermometer and DWM-Worcester computer network clock	See SOP (CN 103.0) and sensor specifications
During-Deployment QC checks (Field Duplicate readings)	Each sensor; min. 1X/month (or more freq. for shorter duration deployments)	+/- 0.2 deg. C	Replace with more accurate sensor; re-deploy	Project Coordinator & QC Analyst	Accuracy as above	See SOP (CN 103.0) and sensor specifications
Post-Deployment Checks	After every use for each sensor	+/- 0.2 deg. C	If data outside acceptance limits, discard or qualify data	Project Coordinator & QC Analyst	Accuracy as above thermometer	See SOP (CN 103.0) and sensor specifications

Table 16: Example of DWM QC Studies (2005-06) *(in order of importance)*

TEST	Approx. DATE(s)	DESCRIPTION
Deployment probes: container and non-recal effects	Spring, 2005	Evaluate multiprobe deployment tubes for possible container effects by comparing continuous side-by-side data for in-tube vs. non-tube. Also compare side-by-side data from field-redeployed units (without re-calibration) vs. pre-calibrated units.
YSI vs. Hydrolab measurements vs. Winkler DO	2005	Perform side-by-side T/DO/COND/pH sampling using YSI and Hydrolab sondes to evaluate variation between meter readings, and between Winkler D.O.s
Nuts lab audits w/ QC samples	Spring, 2005	Prepare known NUTS (TP, NH3-N, etc.) QC samples in proper range for lab analysis. Use purchased (and diluted) ampule samples. Assess analytical accuracy and inter-lab precision by comparing to known "true" values and each lab's results. Share results with all labs.
"Real" TP QC samples	Spring, 2005 (and long-term)	In addition to the use of dissolved audit samples from ampoules as the source for testing the accuracy of the TP procedure, use of prepared **"real" TP samples** containing particulates (where there might be some biotic absorption to the walls and/or settling during analysis) to assess inter-lab precision is proposed. Unlike the dissolved QC samples, this test includes the efficiency of the digestion procedure and the handling procedures (potential for settling when performing sub-sampling). Although there is no "true" value, the results from several labs can be compared to assess capability. Procedure: Collect and modify if needed, a natural lake sample which includes visible amounts of settleable solids (algae or fine sediments) in the range of 30-60 ppb that will be bottled into about 50 sample bottles, acidifed and frozen for use as audit material as needed over the next couple of years (if tests show the TP is relatively stable during storage). Use two clean 5 gallon buckets filled with lake water. If the water appears to be clear, deliberately stir up the bottom silt and organic floc before filling the buckets. Returning to DWM, stir the buckets and send 2 samples to WES for immediate analysis. The buckets will be stored in the dark in a fridge or on ice for a week or so until we get the results back from WES. If the result is less than 30, add more particulates. If the result is greater than 60, dilute with DI to get in the approximate range of 30-60. Then put the two 5 gallon buckets of lake water into a clean garbage can and stir vigourously and with random motion with a paddle while plunging and filling 50 nutrient bottles with about 400ml sample each and acidify them. About 5 gallons will be left unused in the garbage can to avoid any settling effects near the bottom of the can. Send 5 bottles to WES to see the mean and variability of the audit samples. Store "real" samples in DWM freezer. Send some to various labs (double-blind) as needed and record results on a control chart over time to see if there is a trend with time. Hopefully the audit material will be stable for 2 years or more. Also send DI water and the regular EPA type audit samples in the same range (acidified and frozen).

TEST	Approx. DATE(s)	DESCRIPTION
"Real" Chl a sample QC	Spring, 2005	Similar to TP QC above.
Colilert QC: expired reagents vs. un-expired reagents	Spring, 2005	Determine the general usability of expired Colilert reagents for non-DWM-database, semi-quantitative results for preliminary bacteria source tracking sampling, where surveys are focused on finding big "hits". Split large volume samples and run using both unexpired and expired reagents and compare results. Acceptance limits to be determined.
Van Dorn Bottles P contamination testing	Spring, 2005	Screen all Van Dorn bottles in current use for holes in the internal elastic tubes. In lieu of acid-washing (already tested), perform extensive DI rinsing and then do DI soaks (duration TBD), store in bags. Test each one in use with equipment blanks to investigate risk of equipment contamination of samples. Rinse the Van Dorns with lake water before use.
Thermometer accuracy and precision QC	Spring, 2005	Perform side-by-side TEMP sampling using YSI, Hydrolab sondes & HOBO sensors vs. precision, NIST-traceable thermometer to evaluate variation between meter readings.
Interlab compare for bact (e.coli)	Summer 2005	Inter-lab (and inter-method) comparison testing
Field Audits	Summer 2005	Evaluate field performance and adherence to DWM SOPs by regular field staff and seasonal employees via QC Analyst attendance (as 3rd sampler) on field crews.
Inter-lab turbidity measurements	Summer 2005	Perform side-by-side turbidity sampling to evaluate "inter-lab precision" (grabs to WES vs. DWM)
TBD	TBD	As needed

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

Details on the inspection, testing and maintenance of DWM field instruments are contained in Table 17.

For detailed descriptions of inspection, testing and maintenance procedures for WES and other labs, see the applicable lab QAPs and SOPs, adopted herein by reference.

B7 INSTRUMENT/EQUIPMENT CALIBRATION

Details on the calibration of each DWM lab analytical instrument are contained in Table 18.

For detailed descriptions of calibration procedures for WES and other labs, see the applicable lab QAPs and SOPs, adopted herein by reference.

B8 INSPECTION OF SUPPLIES

Several DWM staff are primarily responsible for ensuring the adequacy of supplies and equipment to perform annual monitoring surveys and reporting, as follows:

- Richard Chase: first aid kit contents, field kit contents, Colilert® / Enterolert® reagents and supplies, sampling devices, multi-probe units, misc. safety equipment, phones, cameras
- Jeff Smith: DIW maintenance supplies, probes, calibration reagents, protective equipment
- Brian Friedmann: sample bottles and acid preservative
- Bob Maietta and Greg DeCesare (2005 only): supplies and equipment related to fish toxics and fish population sampling
- Bob Nuzzo: supplies and equipment related to benthic macroinvertebrate sampling
- Edie Blackney: purchasing and accounting; also office supplies
- Joan Beskenis: supplies and reagents for Chlorophyll a analysis
- Bill Dunn: Vehicles
- Misc. staff: project-specific supplies and equipment as needed.
- Arthur Johnson: funding and oversight

Table 17: DWM Field Instrument Calibration and Maintenance

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Hydrolab® Series 3/4 Multi-probe	Jeff Smith, Multiprobe Coordinator Richard Chase, QA/QC Analyst	Pre-cal each day of use, and post-use QC checks	Visual & Electronic; Monthly and/or before each use	Hardware & Software Repair and maintenance as needed.	Pre-survey calibration & post-survey QC checks	Re-calibrate as necessary during pre-calibration; censoring or qualifying data if post-survey check indicates excessive drift or inaccuracies (beyond Table 3 criteria) in comparison to pre-calibrated readings and standard solutions	CN 4.2
YSI 600XLM Multi-probe	Jeff Smith and Richard Chase	Pre-cal each day of use, and post-use QC checks	Visual & Electronic; Monthly and/or before each use	Hardware & Software Repair and maintenance as needed.	Pre-survey calibration & post-survey QC checks	Same as above for Hydrolab® probes	CN 4.2
Velocity Meters (for flow measurement) ***** 1) Price AA 2) Teledyne-Gurley 3) Swoffer 4) Sontek ADV FlowTracker	Jeff Smith, Richard Chase and user	Before each use	Visual & Electronic; Before and after each use	Inspect post-use for damage; lubricate parts as needed per SOP. Also, repair and maintenance as needed.	Prior to each use in the lab; field testing in Spring prior to seasonal use.	Re-calibrate as necessary. If repair and/or re-calibration ineffective, replace with alternate device.	CN 68.0
Lowrance depthfinders (lakes)	Mark Mattson	See SOP 82.1	See SOP 82.1	See SOP 82.1	See SOP 82.1	See SOP 82.1	CN 82.1

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Master-Flex peristaltic pump (field filtration) *****	Richard Chase	NA	Before each use (in the lab)	As needed.	Before each use (in the lab).	Repair as needed.	CN 1.21
Digi-Sense thermometer (NIST-certified)	Richard Chase Jeff Smith	Annually, and as needed based on QC checks.	Visual & Electronic; Before and after each use	As needed.	Annual (Spring) QC check and calibration against WES Lab NIST-certified thermometer per SOP.	Send to manufacturer for re-calibration per SOP.	CN 103.0
Onset Optic Stowaway® Temp Loggers	Richard Chase	Annually, and as needed based on QC checks.	Visual & Electronic; Before, during and after each use; if possible, review data while deployed to ensure working order and accuracy	NA	Annual (Spring) QC check against DWM thermometer and PC Network clock, per SOP.	Replace with working sensor.	CN 103.0
Stormwater samplers (ISCO)	Jeff Smith	N.A.	Before each use and during site visits	Cleaning as needed; re-deploying with new tubes, bottles, etc.	Before each use	TBD (case-by-case)	Instrument Manuals

Table 18: DWM Analytical Instruments Calibration and Maintenance

Instrument	Person(s) Responsible	Frequency of Calibration	Inspection Activity and Frequency	Maintenance Activity and Frequency	Testing Activity and Frequency	Corrective Action (CA)	SOP Reference
Eutechnics thermometer (NIST-certified)	Richard Chase Jeff Smith	Annually, and as needed based on QC checks.	Visual & Electronic; Before and after each use	As needed	Annual QC check and calibration against WES Lab NIST-certified thermometer	Send to manufacturer for re-calibration per SOP	CN 103.0
IDEXX Colilert Sealer	Richard Chase, Joan Beskenis	NA	Prior to each use	Per equipment manual (IDEXX, Inc.)	NA	NA	CN 198.0
Colilert incubators	Richard Chase, Joan Beskenis	NA	Visual; daily when in active use.	Per equipment manual	NA	NA	CN 198.0
Colilert incubator thermometers	Richard Chase, Joan Beskenis	Annually to NIST-certified units	Visual and comparison checks (daily-annually)	NA	NA	Apply correction factor determined from calibration to NIST unit	CN 198.0 and WES SOP for Therm Cal.
Turner TD-700 Fluorometer (Chl a analysis)	Joan Beskenis	Prior to and following the sampling season.	Calibration uses pure or re-hydrated Chlorophyll a preparations, or a solid standard	As needed per SOP.	Periodic QC checks using dehydrated Chl a during seasonal use.	Re-calibrate as necessary per SOP	CN 3.4
Hach color wheel (apparent and true color analyses)	Mark Mattson	NA	Visual; prior to each use	Wipe clean prior to each use	Periodic QC checks during use per SOP	Stop; check procedures; re-test; notify QC Analyst if problem persists	CN 2.2
Turbidimeter	Richard Chase	Prior to each use	Visual; daily when in active use.	As needed per SOP.	Periodic QC checks during use per SOP	Censor or qualify data if QC check data indicate excessive drift or inaccuracies in comparison to standard calibration solutions; notify QC Analyst if problem persists	CN 95.1

NOTE FOR SECTION B9:

SEE ALSO ANNUAL PROJECT-SPECIFIC SAMPLING & ANALYSIS PLANS (SAPs)

B9 NON-DIRECT MEASUREMENTS

Both in planning its own data collection work and using available data to make decisions, DWM assembles data and information from a wide variety of sources. Reliable scientific data and technical information are essential for making appropriate water use assessments and other decisions affecting waterbody health.

For external or non-direct data sources, DWM solicits, accepts and reviews water quality (and other) data and information from all available sources. Preliminary review of these data involves an evaluation based on three main criteria:

- Monitoring is performed consistent with an acceptable Quality Assurance Project Plan including acceptable standard operating procedures;
- Use of an acceptable, preferably state-certified lab (certified for the applicable analyses) that has a documented, acceptable laboratory Quality Assurance Plan (QAP); and
- Results are documented in a citable report that includes QA/QC analyses and data management.

These data sources include monitoring data reports from state and federal agencies and nongovernmental organizations (NGO), as well as reports on projects resulting from state or local grants or federally funded through sections 314, 319, 104, or 604(b) of the CWA.

The following generic list provides some of the possible sources of information for DWM's watershed assessment, TMDL and other work.

State Agencies

Department of Environmental Protection - Drinking Water Program
Department of Environmental Protection - Wetlands and Waterways Program
Department of Environmental Protection - Watershed Permitting Program
Massachusetts Office of Coastal Zone Management (CZM)
Massachusetts Department of Conservation and Recreation (DCR)
Massachusetts Division of Marine Fisheries
Massachusetts Division of Fish and Game
Massachusetts Department of Public Health (DPH)
Massachusetts Water Resources Authority (MWRA)
MassGIS data layers pertaining to land use, percent impervious cover, pollution sources, etc.

Federal Agencies

U.S. Geological Survey
U.S. Environmental Protection Agency

National Estuaries Program
U.S. Fish and Wildlife Service
U.S. Army Corps of Engineers
National Oceanographic and Atmospheric Administration

Private Consulting Firms

Municipal Facilities Plans
Massachusetts Clean Lakes Program “Chapter 628” projects (70 lakes)
Service Contract for Toxicity Testing

Other Sources

Woods Hole Oceanographic Institute
Water Resources Research Center
Massachusetts Institute for Social and Economic Research
Boston Harbor Symposium Abstracts
Colleges, Universities and associated academic institutions
Watershed and lake associations (citizen monitoring programs)
Municipal Conservation Commissions (nonpoint source assessment)
Municipal and Industrial NPDES Permit Monitoring Requirements
Public drinking water systems

More detailed information regarding some of the more influential state program monitoring is provided in Table 19.

Table 19: Potential Water Quality Monitoring Data for DWM Use Available from Massachusetts State Agencies and Programs [Adapted from USGS 2001]

Agency	Program	Description and Focus of Monitoring Program	Sampling Parameters	Type of Sampling Site	Duration of Sampling	Geographic Area of Activity
Cape Cod Commission	Water Resources Office	Site-specific assessment projects	Vary by project	Vary by project	Short term	Cape Cod
Coastal Zone Management	Coastal Water Quality/ Massachusetts Bays	Wetlands health	Dissolved oxygen, pH, nutrients, salinity, macroinvertebrates, vegetation, birds	Fixed	Short term	Coastal areas
	Marine Monitoring and Research	Wetlands assessments; contaminated sediments	Water chemistry, macroinvertebrates, vegetation, birds	Variable	Short term	Coastal areas
Department of Conservation and Recreation	Water Resources/Data Collection and Analysis	Cooperative programs with USGS	Vary by program	Fixed and variable	Short and long term	Varies by program
	Water Resources/Lakes and Ponds	Lakes and ponds in some State parks	Vary by issue	Variable	Short term	Statewide
	Watershed Management/ cooperatively with Massachusetts Water Resources Authority	Drinking-water protection	Nutrients, alkalinity, hardness, bacteria and other pathogens, macroinvertebrates	Fixed	Long term	Quabbin Reservoir, Ware River, and Wachusett Reservoir watersheds
	Watershed Management	Pubic-beach monitoring	Bacteria	Fixed	Long term, summer	Public beaches

Agency	Program	Description and Focus of Monitoring Program	Sampling Parameters	Type of Sampling Site	Duration of Sampling	Geographic Area of Activity
Department of Environmental Protection	Resource Protection/ Drinking Water	Compliance of public-water suppliers with drinking-water regulations	Drinking-water Contaminants	Fixed	Long term	Statewide
	Resource Protection/ Watershed Management	Clean Water Act monitoring and assessment;	Water chemistry; benthic invertebrates; lake vegetation; fish toxics; others	Variable	Short term	Statewide, but focused in “Year 2” basins
Department of Fish and Game	Fisheries and Wildlife	Fish community surveys; special studies related to game fish population	Fish community	--	--	--
	Marine Fisheries	Fish and shellfish health	Dissolved oxygen, temperature, bacteria	Fixed	Long term	Coastal areas
Massachusetts Highway Department	Research and Materials	Highway runoff and public water supplies	Road-salt constituents	Fixed	Variable	Statewide
Massachusetts Water Resources Authority		Water quality in Boston Harbor and tributaries	Sewage contaminants (nutrients, bacteria, others)	Fixed	Long term	Boston Harbor and tributaries; beaches

B10 DATA MANAGEMENT

DWM's data management team facilitates the gathering and storage of raw field data, lab data and associated metadata in hard copy and electronic formats, performs validation and verification procedures to finalize the data, and provides mechanisms for staff and outside-DWM use of these data.

Only DWM-collected data are formally managed in DWM databases. Contracted DEP project data, for example, is not managed in DWM databases (these "external" data reviewed in-house for validity and usability in DWM reporting and decision-making). The only exception to this is the MADEP CERO-SMART monitoring program (based in Worcester, MA.), these data are managed by DWM.

In most cases, monitoring data based on adherence to DWM protocols and based on QAPP planning is formally managed in DWM database(s), to the extent appropriate and applicable. In some cases (e.g., data generated from bacteria source tracking field work), a sub-set of the data only is entered into the database. In the case of source tracking data (unless otherwise specified), only data based on multiple station visits ("base stations") are entered, while single site visit data are not.

Censored data do not become part of the permanent database, and are reported as "censored data" using standard denotation. Data flagged with standardized qualifying language will become part of the database.

B10.1 Data Management Protocols

Table 20: DWM Data Management SOPs

Control Number	SOP
CN 0.40	DWM lab data reporting
CN 0.41	EDD definitions
CN 0.42	EDD template
CN 0.44	Lab data elements
CN 0.6	Station definition
CN 0.8	Data Use
CN 0.9	Data management
CN 56.2	Data Validation

B10.2 DWM Databases

The DWM database system (as of Spring, 2005) is composed of the following primary databases:

- Water Quality Data
- Benthic Macroinvertebrates
- Fish Contaminant Monitoring
- Toxicity Testing Data (TOXTD)
- River Flow Data

- Herbicide Applications
- 303d list/TMDLs
- 305b Water Body System (WBS)

The majority of these are formatted via MS Access and are dynamically linked to the GIS. Each database has specific uses, and the system is intended to allow fast, easy and standardized access to final data for various purposes.

Data are referenced to specific locations in the Commonwealth using waterbody and location identifying codes. These include the Stream and River Inventory System (SARIS), Pond and Lake Information System (PALIS), and "Unique IDs" for specific stations.

DWM is currently (2005) working on a "Database Upgrade" project, which is intended to make the DWM database(s) more efficient to manage, more friendly to end-users, and better equipped to upload to external databases, such as EPA's STORET.

B10.3 Field and Lab Data Entry

The Data Management Group has primary responsibility for fieldsheet data entry. The Principle Investigators (PIs) are responsible for ensuring the completeness and quality of field data prior to data entry. The data entry staff works closely with the PIs on any discrepancies found on the fieldsheets, so they receive timely feedback. This approach also applies to internal DWM lab managers for lab data. A database entry module is provided by the DWM Database Manager to facilitate this transfer.

All completed DWM field sheets, notebook pages and COC forms are filed with the QC Analyst for preliminary review and hard copy filing. A significant amount of the data contained on these forms will be entered into the DWM database. The files are stored at the Worcester office and managed by DWM's Database Manager. Incomplete and/or erroneous field-recorded data and information will be brought to the attention of the appropriate field crew, coordinator and/or person(s). Any field notebook page(s) will be photocopied and added to the final hard copy file.

Laboratory quality-controlled data from WES are sent via the WES Laboratory Information Management System (LIMS) to DWM electronically on an approximate monthly basis. Each successive file overwrites the previous one. These submittals are sent both to the DWM QC Analyst and Database Manager for preliminary QC checks related to holding times and blank/duplicate frequencies. In addition, .snp or .pdf files are sent via email for each lab report for the hard copy file folders. Draft lab data from the DWM Lab (e.g., *E. coli*, Chlorophyll a, color) is also provided to the QC Analyst and Database Manager on standard data forms.

B10.4 Data Availability

After preliminary QC checks, data are available to users as QC Status 1 "raw" data, subject to additional quality control checks and evaluation. "Raw" data are for internal, departmental use only, and its use subject to management approval. After data validation has been completed, and typically within 3-6 months of receipt of lab data reports, the "FINAL" data (QC Status 4 and 5) are available in the database and in hard copy files for internal/external use. It may also be available in published reports.

C1 CORRECTIVE ACTIONS

C1.1 Field-Related Assessment and Correction

Review of field activities related to data integrity and safety is the joint responsibility of the Survey Coordinator for each project, the Monitoring Coordinator and the QA Analyst.

DWM's field audit process calls for the QA Analyst to accompany survey crews to evaluate adherance to SOPs and this QAPP by crews and individual crew members. These field audits attempt to evaluate at least one survey per watershed and, ideally, each survey crew member a minimum of one time. DWM sampling staff in need of performance improvements will be directed to re-read the relevant standard operating procedure and may be re-trained on-site during the evaluation. In addition, yearly field collection sampling reviews may be scheduled if modifications to sample procedures occur. If errors in sampling techniques are consistently identified, mandatory re-training will be scheduled.

C1.2 Lab-Related Assessment and Correction

DWM's QA Analyst has the primary responsibility at DWM to ensure that data from laboratories is consistently of a documented and usable quality. This is done mainly by reviewing lab reports for errors, inconsistencies and poor QC results, but also via frequent communication with lab staff. Ideally, the need for corrective action can be communicated in a timely fashion to avoid future problems and/or data censoring.

For all labs used, the DWM QA Analyst works with each lab to avoid misunderstandings early on. This includes visits to contract labs to discuss method and logistical specifics. In addition, external, single- and double-blind laboratory audits using quantitative QC check samples are typically performed by DWM for nutrients (TP, NH3-N, TKN, NO3-NO2). DWM can also perform self-audits for Colilert® bacteria analysis using external bacteria strains (*E. coli* presence/ absence only) and/or semi-quantitative PE samples (*E. coli* within a defined range).

Assessment of raw laboratory performance is mainly the responsibility of individual labs used (e.g., WES) prior to data transmittal. During QC review at the lab (Levels I, II, III, etc.), it is likely that errors requiring corrective action may be found.

C1.3 Corrective Action Form

A Corrective Action Form must be submitted for all field and laboratory deviations and deficiencies that cannot be handled immediately. This form not only is the first step toward resolution, but also provides documentation of the problem. Refer to DWM's Corrective Action Procedures SOP (CN 5.0) for more information.

C2 QUALITY ASSURANCE REPORTS

The DWM Quality Assurance Analyst is responsible for ensuring that all aspects of data gathering (planning, sample collection, lab analysis, data management, etc.) by DWM results in usable data. To document steps taken and decisions made, an annual **Data Validation Report (DVR)** is produced summarizing QC activities for the Year 2 dataset and detailing all censoring and qualification decisions. The DVR essentially completes the data validation process, resulting in final data.

Additional QA reports may include:

- QC test result summaries (DWM)
- Proficiency Test (PT) summaries (external)
- E-mail communications on various topics, including directives to staff
- "White" paper documents on topical issues

NOTE: Provisional draft data, final data and water quality assessment reports and TMDL evaluations can be obtained by contacting the MADEP, Division of Watershed Management at 627 Main Street, 2nd Floor, Worcester , MA 01608 (508) 792-7470.

D1 DATA REVIEW AND VALIDATION

Decisions to reject or qualify data are made collectively by the Assessment Coordinator, Database Manager, Survey Coordinator and the QA Analyst, and are based on an examination and interpretation of the QA/QC analysis, DQOs, and other criteria, as outlined in DWM's Data Validation SOP (CN 56.2).

Not meeting a specific DQO does not necessarily, in itself, invalidate data. Not meeting several DQOs, however, would likely result in data being censored.

D1.1 "QC Status" Levels for DWM Data

The following categories of "data readiness" are currently used at DWM, as it relates to the use and transmission of draft and final data. All DWM data are categorized into five levels, reflecting the status of review and validation (finalization). The preferred QC Status for use and/or release of DWM data is QC Status 5. Although not recommended, all levels (QC1-5) can be shared with others if requested (e.g. for Freedom of Information Act purposes) with the appropriate disclaimers based on the QC status of the data.

QC Status 1:
Raw data. Not suitable for use or transmission to other parties.

QC Status 2:
Draft data that has been entered into the appropriate DWM database and for which data entry QC has taken place. Not suitable for use or transmission to other parties, except with extreme caution and disclaimer (no technical or project-level review).

QC Status 3:
Draft data for which technical QA/QC review (e.g. QC sample results, outlier identification, comparison to project QAPP DQOs, etc.) has taken place. Not suitable for use or transmission to other parties, except with caution and disclaimer (no project-level review).

QC Status 4:
Final Data. This level of data reflects project-level review by appropriate staff for reasonableness, completeness and acceptability. These data can be freely used and cited in documents without caution or caveat.

The following guidelines pertain to receipt and use of QC Status 4 data:

a) When using, analyzing, presenting or transmitting QC4 data, no changes affecting CONTENT, including symbols and qualifiers used, censoring decisions, etc. are made.
b) The DWM database manager provides QC4 data in a standard WORD electronic format as well as hard copy. As the tables provided represent a DWM office wide standard, no changes, additions or deletions are made to tables without first checking with the database manager – This ensures that data maintained in the database is the same as what is being published in reports.
c) When presenting data, KEYS to symbols and qualifiers are used.
d) For alternate data formats (e.g. Excel), see the Database Manager. Numeric data tables provided in Excel appear different from the text-based tables in MSWord. Standard

Excel files optimized for data analysis are readily available to avoid non-numeric characters denoting detection limits, censoring and qualification (as presented in the text based tables), which are problematic when analyzing data where a true numeric value is necessary.

QC Status 5:
Final data in a published, citable report.

D1.2 DWM Data Qualifiers (complete)

General Symbols (applicable to all types):

" ## " = Censored data (i.e., data that has been discarded for some reason). NOTE: Prior to 2001 data, "**" denoted either censored or missing data.

" ** " = Missing data (i.e., data that should have been reported). See NOTE above.

" -- " = No data (i.e., data not taken/not required)

" <mdl " = Less than method detection limit (MDL). Denotes a sample result that went undetected using a specific analytical method. The actual, numeric MDL is typically specified (eg. <0.2).

Multi-probe-specific Qualifiers:

" i " = inaccurate readings from Multi-probe likely; may be due to significant pre-survey calibration problems, post-survey calibration readings outside typical acceptance range for the low ionic check and for the deionized blank water check, lack of calibration of the depth sensor prior to use, or to checks against laboratory analyses. Where documentation on unit pre-calibration is lacking, but SOPs at the time of sampling dictated pre-calibration prior to use, then data are considered potentially inaccurate.

Qualification Criteria for Depth (i):

General Depth Criteria: Apply to each OWMID#

- Clearly erroneous readings due to faulty depth sensor: Censor (i)
- Negative and zero depth readings: Censor (i); (likely in error)
- 0.1 m depth readings: Qualify (i); (potentially in error)
- 0.2 and greater depth readings: Accept without qualification; (likely accurate)

Specific Depth Criteria: Apply to entirety of depth data for survey date

- If zero and/or negative depth readings occur more than once per survey date, censor all negative/zero depth data, and qualify all other depth data for that survey (indicates that erroneous depth readings were not recognized in the field and that corrective action (field calibration of the depth sensor) was not taken, ie. that all positive readings may be in error.)

" m " = method not followed; one or more protocols contained in the DWM Multi-probe SOP not followed, ie. operator error (eg. less than 3 readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented.

" s " = field sheet recorded data were used to accept data (i.e., not data electronically recorded in a data logger or in cases where data logging is not possible (e.g., single-probes)).

" u " = unstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc.

" c " = greater than calibration standard used for pre-calibration, or outside the acceptable range about the calibration standard. Typically used for conductivity (>718, 1,413, 2,760, 6,668 or 12,900 uS/cm) or turbidity (>10, 20 or 40 NTU). It can also be used for TDS and Salinity calculations based on qualified ("c") conductivity data, or that the calculation was not possible due to censored conductivity data (TDS and Salinity are calculated values and entirely based on conductivity reading).

" ? " = Light interference on Turbidity sensor (Multiprobe error message). Data is typically censored.

Sample-Specific Qualifiers:

" a " = accuracy as estimated at WES Lab via matrix spikes, PT sample recoveries, internal check standards and lab-fortified blanks did not meet project data quality objectives identified for program or in QAPP.

" b " = blank Contamination in lab reagant blanks and/or field blank samples (indicating possible bias high and false positives).

" d " = precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP. Batched samples may also be affected.

" e " = not theoretically possible. Specifically, used for bacteria data where colonies per unit volume for e-coli bacteria > fecal coliform bacteria, for lake Secchi and station depth data where a specific Secchi depth is greater than the reported station depth, and for other incongruous or conflicting results.

" f " = frequency of quality control duplicates did not meet data quality objectives identified for program or in QAPP.

" h " = holding time violation (usually indicating possible bias low)

" j " = 'estimated' value; used for lab-related issues where certain lab QC criteria are not met and re-testing is not possible (as identified by the WES lab only). Also used to report sample data where the sample concentration is less than the 'reporting' limit or RDL and greater than the method detection limit or MDL (mdl< x <rdl). Also used to note where values have been reported at levels less than the mdl.

" m " = method SOP not followed, only partially implemented or not implemented at all, due to complications with sample matrix (eg. sediment in sample, floc formation), lab error (eg. cross-contamination between samples), additional steps taken by the lab to deal with matrix complications, lost/unanalyzed samples, and missing data.

" p " = samples not preserved per SOP or analytical method requirements.

" r " = samples collected may not be representative of actual field conditions, including the possibility of "outlier" data.

D2 DATA VALIDATION METHODOLOGY

A general summary of data validation steps applied to raw monitoring data are as follows. See DWM's Data Validation SOPs (CN 56.1, CN 56.2) for more detailed information.

- Review hard-copy raw data fieldsheets (and field notebook data if available) for accuracy and potential problems; flag all "issues" for later follow-up.
- Review hard-copy raw data COCs for accuracy and potential problems; flag all "issues".
- Perform data entry into the WQD database for all applicable field- and lab data.
- Check accuracy of all data entered into the WQD database ("data entry QC").
- Evaluate field crew performance on specific surveys (and in general, as appropriate) based on the results of field audits; flag "issues".
- Review hard copy DWM laboratory records (lab notebooks, lab bench sheets) for apparent color, chl a analysis, etc. were reviewed for potential effects on data quality and to the need for data qualification or censoring.
- Review hard copy DWM (and that for other "agent" monitoring) Multi-probe calibration books for potential effects on data quality.
- Review hard copy quality control results contained in the WES laboratory data reports for potential implications to data quality and to determine if any data was or should have been qualified by WES (based on lab accuracy and precision data).
- Review hard copy WES laboratory data reports for potential problems, such as missing data, typos, missing pages, correct MDLs/RDLs, etc.
- Evaluate WES (and other labs as appropriate) analytical performance during survey period based on results of QC/PE testing.
- Review hard copy miscellaneous documentation (e-mails, phone records, pers. comms., etc.) to highlight any potential problems affecting data quality.
- Review database report or hard copy for analytical holding time violations; flag/record in DVR.

- Review database report for frequency of QC samples taken for each survey, and compare to DQO for blank and duplicate frequencies.

- Review database report re: all Multi-probe data; produce draft qualify/censor decisions, flag data for follow-up, etc. (assumes that all downloading, reconciliation and post-processing of Multi-probedata has occurred).

- Review database report re: Blank sample results; produce draft qualify/censor decisions, flag data for follow-up, etc.

- Review database report re: Duplicate sample results; produce draft qualify/censor decisions, flag data for follow-up, etc.

- Review available TMs for river/stream, lakes, benthic macroinvertebrates, fish toxics, and other "biological" data for potential issues affecting data quality; flag in annual DVR and follow-up as needed.

NOTE: Draft copies of raw data (or provisional access to draft data) can be issued for project managers, survey coordinators or others with the required, appropriate caveats, such as:

> *"NOTE: This data is currently being validated by MADEP, Division of Watershed Management, and is considered DRAFT. As a result of DWM's data validation process, some of this data may be censored or qualified. Users of this data are cautioned to check with DWM for the latest available and final (published) data."*

D3 DATA USABILITY

As soon as data is of known and documented quality (i.e. “QC Status 4” and “5”) it can be used without caveats for analysis and decision making. The extent to which data is determined to be useful is an on-going in-house evaluation based on issues such as confidence in the data, data conclusiveness, results of data analysis and the degree to which it is actually used appropriately by BRP/DEP/DWM staff and by others. If certain data do not meet the program Data Quality Objectives (DQO’s), data may be censored, qualified or left as draft subject to further review. Any limitations on data use will be detailed in both interim and final reports and other documentation as needed.

Final monitoring data are made available in project-specific technical memoranda, which will include summary quality control evaluations. These memoranda shall support determinations made as part of the watershed assessment and TMDL development processes.

The success of DWM monitoring is evaluated on a continuous basis. The usefulness of the data for each project is evaluated with regard to both programmatic and watershed-specific objectives. Final data are used to answer important questions related to the current health of surface waters in the Commonwealth, as well as the potential for improvement in environmental quality.

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GLOSSARY:

A common understanding of terminology is critical to an effective QA program. All project personnel should have the same working knowledge of these terms. The following terms are commonly-used in describing project QA/QC, from QAPP development to lab analysis and reporting. In most cases, these suggested definitions are entirely consistent with EPA guidance.

PARCC Concepts:

Precision. A data quality indicator, precision measures the level of agreement or variability among a set of repeated measurements, obtained under similar conditions. Precision is usually expressed as a standard deviation in absolute or relative terms.

Accuracy. A data quality indicator, accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. High accuracy can be defined as a combination of high precision and low bias.

Representativeness. A data quality indicator, representativeness is the degree to which data accurately and precisely portray the actual or true environmental condition measured.

Comparability. A data quality indicator, comparability is the degree to which different methods, data sets, and/or decisions agree or are similar.

Completeness. A data quality indicator that is generally expressed as a percentage, completeness is the amount of valid data obtained compared to the amount of data planned.

General QA/QC:

Analyte. Within a medium, such as water, an analyte is a property or substance to be measured. Examples of analytes would include pH, dissolved oxygen, bacteria, and heavy metals.

Bias. Often used as a data quality indicator, bias is the degree of systematic error or inaccuracy present in the assessment or analysis process. When bias is present, the sampling result value will differ from the accepted, or true, value of the parameter being assessed in one direction. Bias should not be used interchangeably with accuracy.

Censored data: Data that has been found to be unacceptable as a result of the data validation process, including review for conformance to the approved QAPP and data quality objectives for the project (ex. required holding times for analysis, required frequency of field blanks and duplicates/splits, acceptability of precision estimates (standard deviation, SD or relative percent difference, RPD).

Chain-of-Custody: Used for routine sample control for regulatory and non-regulatory monitoring. The chain-of-custody form contains the following information: sample IDs, collection date/time/samplers, sample matrix, preservation reqts., delivery persons/date/time, etc… Used also as a general term to include sample labels, field logging, field sheets, lab receipt and assignment, disposal and all other aspects of sample handling from collection to ultimate analysis.

Data users. The group(s) that will be applying the data results for some purpose. Data users can include the principle investigators, as well as government agencies, schools, universities, watershed organizations, and business and community groups.

Data quality objectives (DQOs). Data quality objectives are quantitative and qualitative statements describing the degree of the data's acceptability or utility to the data user(s). They include indicators such as accuracy, precision, representativeness, comparability, and completeness (PARCC). DQOs specify the quality of the data needed in order to meet monitoring project goals.

Matrix. A matrix is a specific type of medium, such as surface water or sediment, in which the analyte of interest may be contained.

Measurement Range. The measurement range is the extent of reliable readings of an instrument or measuring device, as specified by the manufacturer.

Method Validation: Testing procedure for existing, new and modified methods, in which several evaluation steps are typically employed: determinations of MDL, method precision, method accuracy, and sensitivity to variation in method steps ("method ruggedness", SM, 1998).

Performance Audit: Unscheduled evaluation of field sampling QC or laboratory QC procedures by a third party not directly involved in the taking, transport and analysis of the samples; used to detect deviations from accepted SOPs. Audits can take many forms. Submittal of identical check samples to two different labs is an example of an external, blind performance audit. Inter-lab comparison samples can also be used to test the lab's proficiency in relation to other labs. Results of audits are documented and any necessary corrections recommended.

Protocols. Protocols are detailed, written, standardized procedures for field and/or laboratory operations.

Quality assurance (QA). QA is an integrated management system designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. QA activities involve planning quality control, quality assessment, reporting, and quality improvement. These activities can be internal (within the main group) or external (involving outside parties).

Quality assurance project plan (QAPP). A QAPP is a formal written document describing the detailed quality control procedures that will be used to achieve a specific project's data quality requirements. A QAPP is a planning tool to ensure that project goals are achieved. Typically, QAPPs are finalized prior to monitoring activities and any deviations from the final QAPP made during the actual monitoring are noted in a subsequent task, such as the data reporting phase of the project. QAPPs can be of two main types:

- A "project-specific QAPP" provides a QA blueprint specific to one project or task and is considered the sampling and analysis plan/workplan for the project.

- A “generic program QAPP” is an overview-type plan that describes program data quality objectives, and documents the comprehensive set of sampling, analysis, QA/QC, data validation and assessment SOPs specific to the program. An example is a macroinvertebrate monitoring program performed throughout many watersheds within a State.

Quality control (QC). QC is the overall system of technical activities designed to measure quality and limit error in a product or service. A QC program manages quality so that data meets the needs of the user as expressed in a quality assurance project plan. Specific quality control samples include blanks, check samples, matrix spikes and replicates.

Random Sample: A sample chosen such that the choice of each event in the sample is left entirely to chance; an unbiased sample generally representative of the population. Randomness is a property of a sample that must exist for almost any statistical test, but may not be appropriate for all sampling designs (ex. Non-random site selection based on targeting specific conditions or based on practical considerations).

Relative standard deviation (RSD). A measure of precision calculated by dividing the std. deviation by the mean, expressed as a percentage. Used when sample number exceeds two.

Relative percent difference (RPD). A measure of precision used for duplicate sample results. It is calculated by dividing the difference between the two results by the mean of the two results, expressed as a percentage. Used when sample number equals two.

Sensitivity. Similar to resolution, sensitivity refers to the capability of a method or instrument to discriminate between measurement responses.

Standard deviation(s). Used in the determination of precision, standard deviation is the most common calculation used to measure the range of variation among repeated measurements. The standard deviation of a set of measurements is expressed by the positive square root of the variance of the measurements.

Standard operating procedures (SOPs). An SOP is a written, official document detailing the prescribed and established methods used for performing project operations, analyses, or actions. Each DWM SOP is reviewed and approved for accuracy and applicability by DWM managers.

Trend: Systematic tendency over time in a specific direction in time series data, ideally collected at uniform intervals, collected and analyzed using the same (or comparable) methods and containing no gaps in periodic data.

True value. In the determination of accuracy, observed measurement values are often compared to true, or standard, values. A true value is one that has been sufficiently well established to be used for the calibration of instruments, evaluation of assessment methods or the assignment of values to materials.

Variance. A statistical term used in the calculation of standard deviation, variance is the sum of the squares of the difference between the individual values of a set and the arithmetic mean of the set, divided by one less than the numbers in the set.

Field Quality Control:

Duplicate sample. Used for quality control purposes, field/lab duplicate samples are two samples taken generally at the same time from, and representative of, the same site/sample that are carried through all assessment and analytical procedures in an identical manner. Field duplicate samples are used to measure natural variability as well as the precision of field sampling and lab analytical methods. Lab duplicates are used as a measure of method precision. More than two duplicate samples are referred to as replicate samples.

DWM field blank water: Deionized water made available by properly-maintained and -functioning water filtration system located in DWM laboratory.

Environmental sample. An environmental sample is a specimen of any material collected from an environmental source, such as water or macroinvertebrates collected from a stream, lake, or estuary.

Field blank. A field blank is created by filling a clean sample bottle with deionized or distilled water in the field during sampling activities. The sample is treated the same as other samples taken from the field. Field blanks are submitted to the lab along with all other samples and are used to detect any contaminants that may be introduced during sample collection, fixing, storage, analysis, and transport.

Field composite sample: A sample taken by mixing equal volumes of a pre-determined number of grab samples from the same location at different times, ie. a time-composite. Used to assess average conditions present between the first and last grab samples that are composited. Use time-composite sampling only for those parameters that can be shown to remain unchanged under the specific conditions of composite sample collection. Flow-weighted composite sampling is a variation to time-composite sampling, in which sample volume adjustments are made to each grab based on variations in flow, such as occurs during stormwater monitoring loading studies.

Field integrated sample: A sample taken by simultaneously combining a matrix across vertical or horizontal strata as an evaluation of average composition within the boundaries of the integration (ex. Photic zone sampling for chlorophyll a). Sampling tubes can sample continuous, integrated media.

Field Split: A second sample generated from the same sampling location and at the same time by splitting a large volume sample from one sampler deployment into two equal volume samples. Used to measure precision, except that associated with actual sample collection, and excludes natural variability. Also referred to as duplicate subsample.

Field Duplicate (sequential): A second sample generated from the same sampling location as the initial sample, but from a second sampler deployment immediately after the first. Used to measure overall field sampling precision and includes an unknown amount of natural variability (spatial and temporal), if present.

Field Duplicate (simultaneous): A second sample generated from the same sampling location and at the same exact time as the other sample by simultaneous deployment of two identical sampling devices or by the simultaneous filling of two separate sample bottles. Used to measure overall field sampling precision and includes an unknown amount of natural variability (spatial), if present. Also referred to as a co-located duplicate.

Grab Sample: A manually collected sample at a specific location and time. Given practical constraints and budget limitations, assumptions are usually made that the natural variation is small enough over space/time to consider the grab to be representative of conditions over a greater expanse and/or longer period. In some cases, these assumptions may not always be valid.

Laboratory Quality Control:

Blind sample. a blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the analyst's or laboratory's expertise in performing the sample analysis.

Calibration Blank. Reagent-grade, purified water (deionized/distilled) used as a zero standard; used to “zero” lab instruments, evaluate instrument drift and check for sample contamination of field blanks.

Calibration Check Standard: A standard used to check the calibration of an instrument between periodic recalibrations.

Detection limits. Applied to both methods and equipment, detection limits are descriptions of the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain as greater than zero. Specific detection limits include: Instrument detection limit, level of quantitation, lower level of detection, method detection limit, practical quantitation limit and reporting detection limit.

Instrument detection limit (IDL) The concentration that produces a signal greater than five times the signal/noise ratio of the instrument.

Level of Quantitation (LOQ): The concentration that produces a signal sufficiently greater than the blank that it can be detected; typ. The concentration that produces a signal 10*s above the blank signal. Typically, ten times the IDL (SM, 1998) .

Lower level of detection (LLD): Measurement level reproducible with 99% certainty; typically twice the IDL.

Method detection limit (MDL). The MDL is the concentration that produces a signal with a 99% probability that it is different from the blank, after going through the entire method. The smallest amount that can be detected above the noise in a procedure and within a stated confidence level. Typically, four times the IDL.

Practical Quantitation Limit (PQL). The lowest concentration level that several labs can report using the same method and samples; typically, ten times the IDL, and 3-5 times the MDL.

Reporting Detection Limit (RDL). The lower limit that the lab feels comfortable reporting with a high level of certainty. For practical purposes, the RDL is often equivalent to the MDL.

Equipment or rinsate blank. Used for quality control purposes, equipment or rinsate blanks are types of field blanks used to check specifically for carryover contamination from reuse of the same sampling equipment (see field blank).

Lab Split: A sample that has been divided into two or more subsamples. Splits are submitted to different analysts or laboratories and are used to measure the precision of the analytical methods. Lab splits are an external QC protocol.

Lab duplicate: A sample that has been divided into two or more subsamples. It is processed concurrently and identically with the initial sample by the same laboratory. It is used to measure the precision of the analytical methods. Lab duplicates are also referred to as lab splits.

Method Blank: An aliquot of clean reference matrix carried through the analytical process to assess the degree of laboratory contamination and indicate accuracy.

Matrix Spike: A sample to which a known concentration of target analyte has been added. When analyzed, the difference in analyte concentration between a spiked sample and the non-spiked sample should be equivalent to the amount added to the spiked sample. Lab QC sample used to assess sample matrix effects on recovery of target analyte and evaluate accuracy. Also known as Lab-fortified matrix. Duplication of this sample is referred to as matrix spike duplicate or lab-fortified matrix duplicate.

Performance evaluation (PE) samples. A sample of known concentration submitted “blind” (without lab’s knowledge) to the analyst. PE samples are provided to evaluate the ability of the analyst or laboratory to produce analytical results within specified limits, and as an indicator of method accuracy. Also called a laboratory control sample.

Spike Blank: Known concentration of target analyte(s) introduced to clean reference matrix and processed through the entire analytical procedure; used as an indicator of method performance and accuracy. Also known as Lab-fortified blank.

Standard reference materials (SRM). An SRM is a certified material or substance with an established, known and accepted value for the analyte or property of interest. Employed in the determination of bias, SRMs are used as a gauge to correctly calibrate instruments or assess measurement methods. SRMs are produced by the U. S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of any analytical method.

Qualifier: Used to indicate additional information about the data, and generally denoted as capital letters in data reports. Qualifier acronyms or terms are unique to each laboratory.

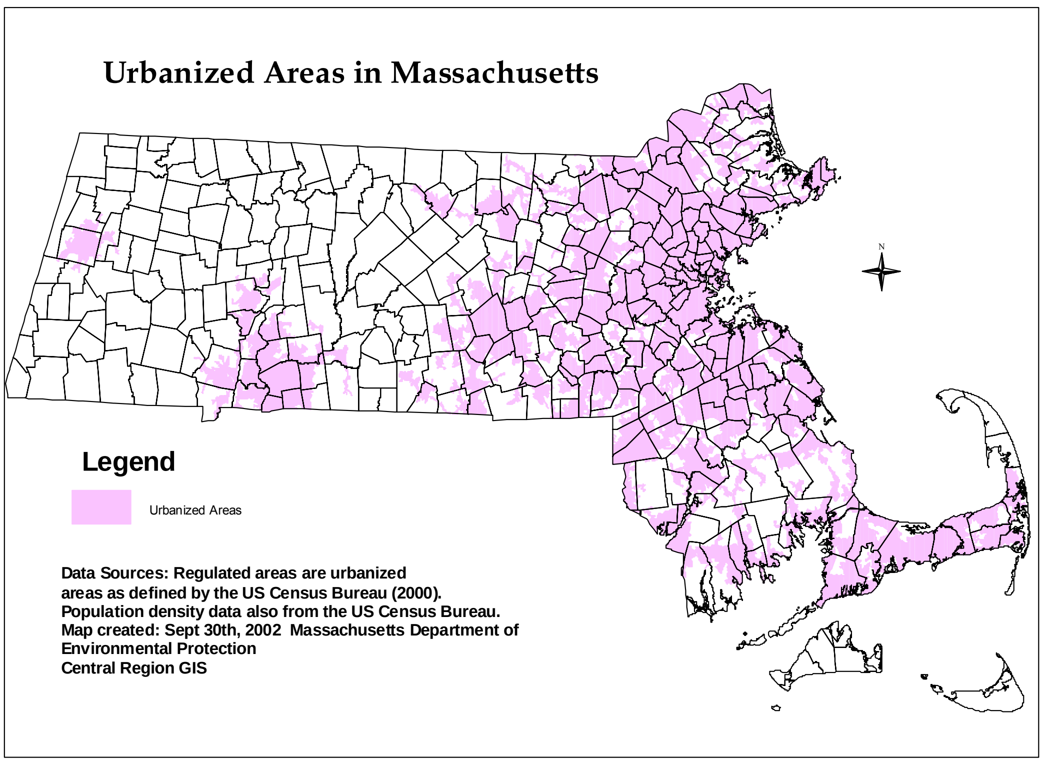
Quality Assurance Plan (QAP): A comprehensive laboratory document detailing lab quality control procedures (eg. WES QAP).

WES Lab SOP Manual: A collection of analyte-specific laboratory standard operating procedures (SOPs) used for analysis of samples. As of 1/2001, this “manual” is composed of separate, individual SOPs for selected analytes (not a bound, complete manual). Some SOPs used at WES are currently undocumented as formal SOPs.

APPENDIX A

Massachusetts Watersheds

PENDING



APPENDICES B-G

Adopted herein by reference; available on DWM QAPP CD

Appendix B: Statewide Water Quality Network for Massachusetts (by reference; on QAPP CD)

Appendix C: DWM Biological Assessment Monitoring Program QAPP (by reference; on QAPP CD)

Appendix D: DWM Fish Toxics Programmatic QAPP (by reference; on QAPP CD)

Appendix E: CERO “SMART” Program QAPP (non-DWM; by reference; on QAPP CD)

Appendix F: WES Laboratory QA Plan and SOPs (by reference; on QAPP CD)

Appendix G: DWM monitoring, analytical and data management SOPs (by reference; on QAPP CD)

APPENDIX H

DWM's Bacteria Source Tracking "Toolbox" *(conceptual)*

In order to address the very high number of water quality impairments due to chronic and episodic exceedances of bacteria water quality standards, DWM can use a microbial source tracking (MST) toolbox approach to locate the sources.

While the potential sources of elevated bacteria levels in surface waters are limited (e.g., pets, wildlife, failing septic systems, sewer line leaks/spills, stormwater runoff, CSO's, farms) and are generally associated with specific landuses, ambient bacteria levels can be highly variable within and between sites, making it often difficult to distinguish patterns, track differences and reach conclusions. As a result, the protocol is based on focused intensive bacteria sampling combined with a comprehensive subwatershed characterization and close coordination with municipalities, local agencies and volunteer groups that can supply important site-specific knowledge to direct sampling, assist in identifying potential sources, and participate in recommended clean-up actions.

Within selected sub-watersheds, multiple sampling rounds for *E. coli* as well as analysis of other parameters can provide information to help locate potential source areas or "hot spots". Other techniques can help distinguish between human and non-human sources of bacteria. Data from one round of sampling can provide the clues to direct the focus of the next sampling round. Sampling results, associated sub-watershed information, and local input will be used to identify sources of bacteria contamination to the extent of DEP jurisdictional authority, at a minimum. Appropriate authorities will be notified of the suspected source(s) and recommendations for further source tracking work (e.g., for Phase II communities engaged in detecting and eliminating illicit discharges), immediate clean-up, or DEP enforcement action will be made.

The general approach of planning and conducting bacteria source tracking follows a sequence of standardized steps, however it is expected that each sub-watershed presents unique situations that require flexible sampling planning.

Specific objectives to accomplish bacteria source tracking goals are as follows:

- identify subwatersheds known to be impacted by bacteria (historical data that violate WQ standards, Integrated List (303d list), local input);
- prioritize and select contaminated subwatershed(s) to perform source tracking;
- conduct subwatershed characterization (landuse evaluations, historical data reviews, local interviews, GIS mapping, stormwater permit information, field recon, stream walks, etc);
- conduct screening level bacteria sampling (Colilert *E. coli* during wet and dry conditions);
- review data, refine sampling plan, implement iterative source tracking sampling utilizing "toolbox" of options (e.g., Colilert *E. coli,* fecal coliform, specific conductivity, stream height, optical brighteners, fluorescent whitening agents);
- identify sources of bacteria to DEP jurisdictional level;
- recommend appropriate action to initiate remediation (via DEP enforcement or municipal action)
- document bacteria source tracking conducted within the subwatershed.

The general steps are as follows:
 Identify and prioritize contaminated subwatershed(s) to perform source tracking.

- Create a listing of all sub-watersheds within the study watershed.
- Develop a decision table to prioritize and select sub-watersheds for source tracking sampling. Decision table uses available information including: historical water quality data, assessment report recommendations, field reconnaissance notes, Integrated List, TMDL needs, access restrictions, stakeholder input, severity of bacteria contamination, number of river miles not meeting bacteria standards, potential sources based on land use information, public health concerns (i.e., informal swimming known to occur in affected segment).
- Compare subwatershed information and select several of the most impaired and/or most feasible for further evaluation.
- Perform more detailed Decision Table evaluation on selected subwatersheds using all available information, including review of additional historical bacterial level data (published and non-published), interviews with local stakeholders, and initial field reconn. Modify priority of sub-watersheds for sampling.
- Select top (4) sub-watersheds for more in-depth characterization, field recons (windshield surveys, shoreline surveys) and screening level sampling.
- Decision table evaluation and subwatershed priority re-ranking is on-going process through-out sampling season and will depend on field recon information and screening sampling results.

Characterize Priority Subwatershed(s):

- Map subwatershed: include roads and other transportation if appropriate, surface water hydrography, topography, landuses, impervious surfaces.
- Create working field map(s) of subwatershed using USGS topo or GIS baseline maps.
- Confirm and refine GIS landuse information via field recon (windshield surveys).
- Identify Phase I and II stormwater regulated areas within subwatershed. Obtain maps of stormdrain system and outfalls if available.
- Identify sewered/unsewered areas within subwatershed.
- Conduct interviews with local volunteer groups, municipal DPWs, Boards of Health, streamside landowners, etc. to get local input to help: refine list of possible sources; acquire additional information on infrastructure (sewering, stormdrain system, CSOs, septic systems); gain access to streams and/or sampling sites; organize volunteers for shoreline surveys; focus sampling design.
- Refine list of potential point and non-point sources of "hot spot' bacteria pollution based upon GIS ortho-photos, local interviews, local stormwater and sewer information, and field recon. List all potential sources of bacteria contamination from information gathered (e.g., farms (type), failing septic systems, storm water runoff, illicit connections, CSOs, wildlife, sewer leaks and breaks, dumping)
- Conduct shoreline surveys to confirm and refine list of potential sources, locate and evaluate outfalls, tributaries and other contributing point and non-point drainage to affected segment, locate potential sampling stations and access points (at "pour points"). Photo document potential point and non-point sources of bacteria contamination. Use

working field maps to record shoreline survey information including sampling sites and access.

- Utilize watershed associations and volunteers for initial field recons and shoreline surveys, where possible.

Design and Conduct Screening Level Sampling Plan:

- Select sampling sites at mouths of all tributaries and in mainstem above confluence with tributaries (i.e., pour point(s)).
- Select 20% additional sampling sites to be located at sites of documented contamination and/or at potential "hot spots" based upon historical information and data, shoreline surveys, land use, and interviews with local stakeholder groups including watershed associations, DPWs, and Boards of Health (consult data from Decision Table).
- Additional field recon may be needed to establish access and/or confirm significance of sampling station(s).
- Conduct at least two screening level sampling runs in the spring – one dry and one wet. Characterization of dry or wet weather sampling is determined just prior to sampling through antecedent precipitation and water heights.
- Conduct one round of dry weather sampling at stations selected above. Dry weather sampling rounds follow a minimum of 3 days with less than 0.1 inches of rain. Samples collected for Colilert analysis at DWM, Worcester. Specific conductance measured *in-situ* and water height measurements taken at nearby road crossings.
- Conduct one round of wet weather sampling at stations identified above. Wet weather sampling conducted as closely as possible to within the first 1 hour of a rainfall event forecasted to produce at least 0.25 inches of rain. Samples collected for Colilert analysis at DWM, Worcester and water height measurements taken at nearby road crossings. Sampling conducted just prior to and twice during storm.

Evaluate screening level Data, Design and Conduct Source Tracking Monitoring:

- Establish a source tracking advisory team (STAT) within DWM.
- Convene STAT (within 24 hours of obtaining Colilert results) to evaluate screening level data and help survey coordinator plan next steps.
- If data show no levels above standards, STAT may recommend either moving to next priority ranked sub-watershed for screening level sampling or planning and conducting additional wet weather and/or dry weather sampling in same subwatershed on first available sampling date.
- If data show elevated (above standards) bacteria levels, design targeted source tracking monitoring plan with help of STAT to target area(s) of elevated bacteria and begin to isolate source(s) of contamination. Overlay screening sampling data onto land use GIS maps to help identify potential sources. (Check ortho photos to identify additional small streams, which may not show up on GIS maps.)
- Conduct targeted sampling with Colilert, stream height measurements at road crossings, and *in-situ* specific conductance measurements (during dry weather only). Sampling strategy will include bracketing suspected point sources (e.g., pipes, ditches, culverts) and non-point sources (e.g., specific land uses, small tributaries, neighborhoods). Sampling stations should also include "pour point" stations established during screening level sampling to document and track reference conditions.

- Maintain photographic summary to visually identify and document potential source(s) for follow-up and enforcement.
- Convene STAT to evaluate results within 24 hours of every sampling round. Additional bacteria, stream height and specific conductivity monitoring may be required to further isolate sources and/or determine degree of wet weather influence. Dry and wet weather sampling may again be required. Sampling station locations and sampling design will again depend on STAT evaluation.
- Targeted sampling may be conducted during wet and/or dry weather depending on decision of STAT and will be based on likely sources of contamination (e.g., impervious surfaces – more wet weather sampling; septic systems – more dry weather sampling).
- Determine the need (with STAT) for source differentiation based on potential sources of contamination upstream of hot spot(s). (optical brighteners and/or fluorescent whitening agents). Conduct source differentiation survey(s) as appropriate.

Identify Source(s) of Bacterial Contamination to DEP Jurisdiction:

- Convene STAT and evaluate results. Identify source(s) and determine responsible authority(ies), if appropriate.
- Failing septic systems – notify regional DEP office and local BOH. BOH may need to do additional monitoring to identify specific system(s) that are failing.
- Illicit connections – notify regional DEP office and local stormwater management authority if under a stormwater permit (e.g., DPW). Local authority may need to do additional work to locate illicit connection(s) within storm drain system such as TV inspections and dye testing.
- Agriculture – notify NRCS and local BOH
- Infrastructure failures (leaking sewer lines, sewer breaks) – regional DEP office and local DPW or sewer district manager. Locals may need to do more work to locate site(s) of failure(s).
- CSO's – DEP
- Stormwater runoff – notify local authorities, recommend 319 grant program to remediate if appropriate
- Wildlife – MA DFW

Document bacteria source tracking conducted within the subwatershed:

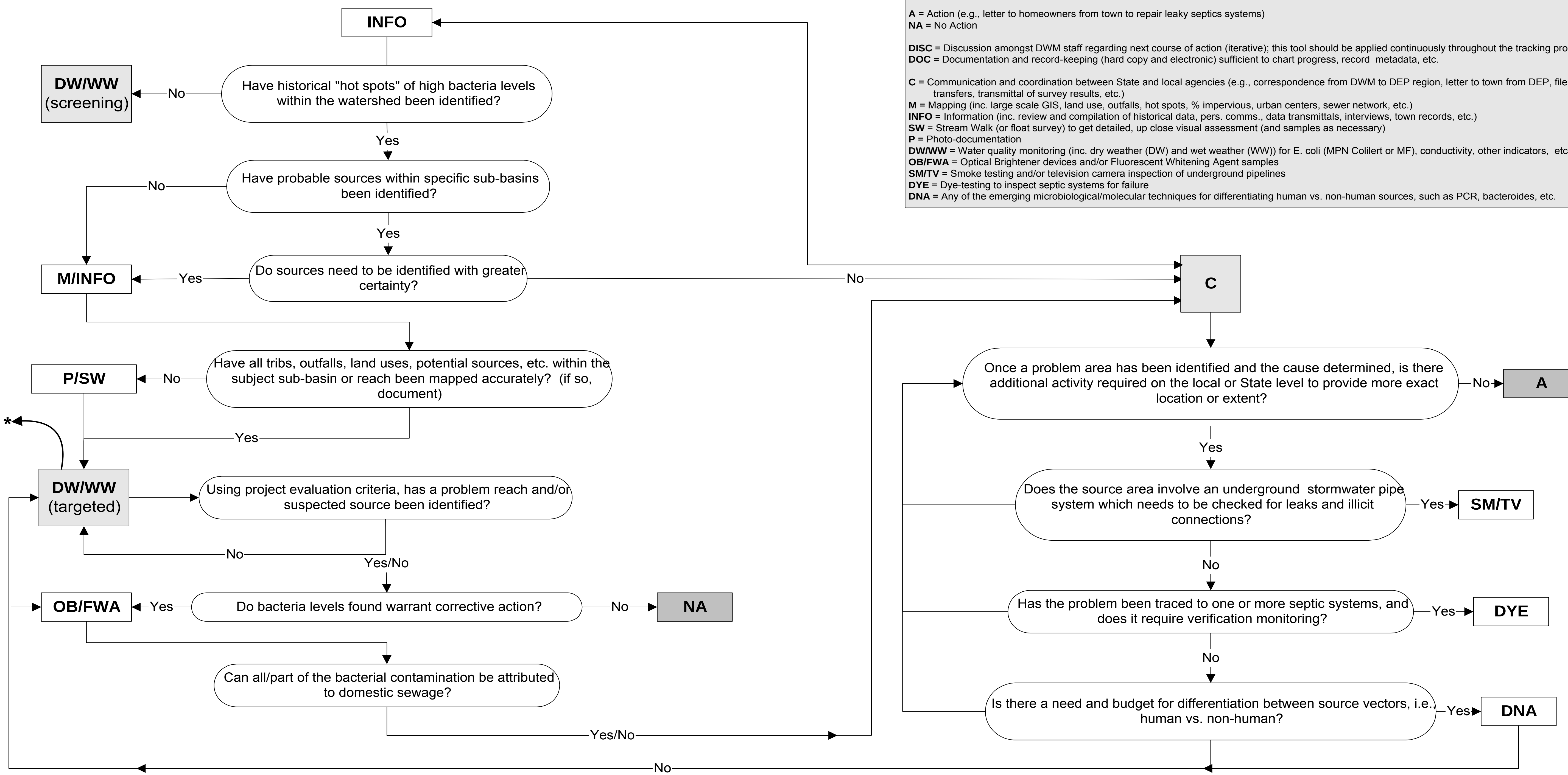
- Prepare Bacteria Source tracking Monitoring Report to include:
  - Evaluation/priority ranking Decision Table showing sub-watersheds and selection process.
  - Maps, summary of field notes, sampling plan, photo documentation of potential sites.
  - Summary of local input, contacts
  - Summary by sub-watershed of Integrated List (303d and 305b) segments sampled with results.
  - Recommendations for listing or delisting selected segments.
  - Segments identified for high bacteria levels, together with responsible regulatory authority, and recommended clean-up activity and time-line.

"Toolbox":

A = Action (e.g., letter to homeowners from town to repair leaky septics systems)
NA = No Action

DISC = Discussion amongst DWM staff regarding next course of action (iterative); this tool should be applied continuously throughout the tracking process
DOC = Documentation and record-keeping (hard copy and electronic) sufficient to chart progress, record metadata, etc.

C = Communication and coordination between State and local agencies (e.g., correspondence from DWM to DEP region, letter to town from DEP, file transfers, transmittal of survey results, etc.)
M = Mapping (inc. large scale GIS, land use, outfalls, hot spots, % impervious, urban centers, sewer network, etc.)
INFO = Information (inc. review and compilation of historical data, pers. comms., data transmittals, interviews, town records, etc.)
SW = Stream Walk (or float survey) to get detailed, up close visual assessment (and samples as necessary)
P = Photo-documentation
DW/WW = Water quality monitoring (inc. dry weather (DW) and wet weather (WW)) for E. coli (MPN Colilert or MF), conductivity, other indicators, etc.
OB/FWA = Optical Brightener devices and/or Fluorescent Whitening Agent samples
SM/TV = Smoke testing and/or television camera inspection of underground pipelines
DYE = Dye-testing to inspect septic systems for failure
DNA = Any of the emerging microbiological/molecular techniques for differentiating human vs. non-human sources, such as PCR, bacteroides, etc.



MADEP-DWM Conceptual Approach to Bacteria Source Identification (2004). Objective: To locate and determine the physical source(s) causing elevated bacteria levels in ambient surface waters

* See decision table

APPENDIX I

Examples of Selected DWM Fieldsheets, COC Form, laboratory forms and miscellaneous checklists

Massachusetts Department of Environmental Protection/Division of Watershed Management

River and Stream Survey Fieldsheet

2005

Project Lead (initial) S.H.

Rivers and Streams

Station Sheet 1 of 1.

General Information (*fill out prior to departure*)

Project	Deerfield	**General weather conditions last 3 days at:**	Greenfield
River	Wheeler Brook	(*http://www.erh.noaa.gov/box/dailystns.shtml*)	(*See attached NOAA weather report*)
Town	Greenfield	**Sampling Survey Crew** full names (*last name is OK for year round DWM employees*)	
Site Name	WH01	**Crew Lead:** S. Holmes	**Others:** D. Watson

Station Information (*fill out at station for observable station area (within 10 meters up/down)*) ***DETERMINE LEFT/RIGHT BANK BY LOOKING DOWNSTREAM)***

Date: 9/18/05 **Time (*24 hr*):** 1144 AM ✓ PM ___ **Flowing** ☑ **No Water** ☐ **Pooled** ☐ **Photos taken?** Yes ✓ No ___

Station Description (*Use DWM station file descriptions; if pre-typed, confirm no changes to description by checking this box* ☐ *, OR edit text based on changes*)

~100 m upstream from Rt. 2 near Old Greenfield Rd. RR X-ing

Station Access (*provide detailed information on how to get to sampling area and how sampled*)

no easy access for wade-in — sampled from upstream side of X-ing w/ basket drop

Riparian Area (*provide brief description*) very thick Understory ; good canopy

% Open Sky (☐ densiometer ☐ clinometer ☑ visual estimate; *0-100%; e.g., totally open=100%; total canopy shade=0%*) = 10%

Weather (*check one only*)	**Air Temperature** (°F)	**Wind Conditions**	**Water Odor**	**Water Clarity** (*check most applicable, based on visual, in-stream appearance; same for color*)	**Water Color**
☐ Clear	☐ <20	☐ Calm (0-1 mph)	☑ None	☐ Unobservable (____)	☐ Unobservable (____)
☐ Mostly sunny	☐ 20-30	☑ Slight breeze (1-5 mph)	☐ Sulfide (rotten egg)	☑ Clear	☑ Clear
☐ Mostly cloudy	☐ 30-40	☐ Moderate winds (5-15 mph)	☐ Fishy	☐ Slightly turbid	☐ Greyish
☐ Overcast	☐ 40-50	☐ Strong gusts (15-25 mph)	☐ Septic	☐ Moderately turbid	☐ Brownish
☐ Humid	☐ 50-60	☐ Storm winds (> 25 mph)	☐ Raw sewage	☐ Highly turbid/ murky	☐ Blackish
☐ Foggy	☐ 60-70	**Average Water Velocity**	☐ Chlorine		☐ Reddish
☑ Drizzly	☑ 70-80	☐ ~0 fps ☐ 3-5 fps	☐ Petroleum		☐ Light yellow
☐ Rain	☐ 80-90	☐ < 1 fps ☐ > 5 fps	☐ Musty (basement)		☐ Dark tan
☐ Sleet	☐ 90-100	☑ 1-3 fps	☐ Rotting vegetables		☐ Rusty (orangish)
☐ Snow	☐ >100		☐ Other ______		☐ Greenish
					☐ Other ______

River Water Level (*vs. mean AHWL*)

(*AHWL= annual high water line*)

☑ Low (estimate minus ______ feet)

- Exposed substrates? ☑ NO ☐ YES

☐ Normal

☐ High (estimate plus ______ feet)

Staff gage reading (*feet*): —

(*gage=*)

Fixed-point vertical distance to H20 surface (*feet*): 9.8'

(*fixed-point=* top edge of metal trestle to water)

Aquatic Plants (*check one ONLY for overall density; circle type*)

Sparse=~1-25% (S) Moderate=25-50% (M) Dense=50-75% cover (D) Very Dense=75-100% cover (VD)

Overall Density	**Dominant Plants and Type** (*E=emergent S=submerged F=floating*)
☐ Unobservable (*why:* ____)	______ E / S / F
☐ None	______ E / S / F
☑ Sparse	______ E / S / F
☐ Moderate	______ E / S / F
☐ Dense	**Exotics:** too far away (cannot estimate)
☐ Very Dense	

Phytoplankton Presence (*check one*)

☐ Unobservable ☐ Suspended in water column ☑ None ☐ Floating clumps/mats

Periphyton (*check ALL that apply; density=area covered*)

☑ Unobservable (*why:* on bridge)

☐ None

☐ **Filamentous** S / M / D / VD ☐ On plants ☐ On rocks ☐ On bottom ☐ On woody debris ☐ Riffle ☐ Run ☐ Pool Color: ______

☐ **Film** S / M / D / VD ☐ On Plants ☐ On Rocks ☐ On bottom ☐ On woody debris ☐ Riffle ☐ Run ☐ Pool Color: ______

☐ **Loose Floc** S / M / D / VD ☐ On Plants ☐ On Rocks ☐ On bottom ☐ On woody debris ☐ Riffle ☐ Run ☐ Pool Color: ______

☐ **Moss** S / M / D / VD

Bottom Substrate (*check all that apply; estimate. % cover & add to 100%*): ☑ Bedrock (10 %) ☑ Boulder (25 %) ☑ Cobble (25 %) ☑ Coarse gravel (25 %) ☑ Sand (10 %) ☐ Silt (___ %) ☐ Mud (___ %) ☑ Clay (5 %) = 100% **OR** ☐ **Unobservable**

Sampling Location Information (*for the observable station area (within 10 meters up/down)*) ***If unobservable, note why in the decriptions***

Floating Scum(s)? ☐ unobservable ☑ NO ☐ YES *If yes:* ☐ oil sheens ☐ pollen/dust blankets ☐ algal mat ☐ foam ☐ other

Describe Scum(s):

Uses Observed? ☐ unobservable ☐ NO ☑ YES *If yes:* ☐ swimming ☐ boating ☐ water intake ☑ fishing ☐ other

Description of Observed Use(s) or Indicators of Use(s) (*include numbers as applicable*): 2 boys

Objectionable Deposits? ☐ unobservable ☑ NO ☐ YES *If yes:* ☐ trash ☐ flocculent mass ☐ other

Description of Objectionable Deposits (*type, extent and area affected…*):

Shoreline Erosion? ☐ unobservable ☐ NO ☑ YES (*note locations and extent of undercut banks, existing and potential slope failures, landslides, etc.*)

Description of Erosion: slight @ some banks

Wildlife Sightings? ☐ unobservable ☐ NO ☑ YES *If yes:* ☑ fish ☐ mammals ☑ birds ☐ reptiles ☑ waterfowl ☐ amphibians ☐ other

Description of Wildlife Sightings and/or Indications (*e.g. geese droppings, nests, etc.; include numbers as applicable*):

Potential Pollution Sources? ☑ none ☐ outfall pipes (*storm, wwtp, etc.*) ☐ garbage dumping ☐ land clearing ☐ lawns ☐ septic ☐ road runoff ☐ other

Description of Potential Pollution Sources:

For office use only Field Sheet Login # Unique ID # Revision Date 3/2005

Example of completed 2005 Rivers Field Sheet (side one).

SAMPLE DATA

Bottle Sample(s) collected? ☑ yes ☐ no

Samples taken from *(check all that apply)*

☐ from shore ☐ wade in ☐ boat ☐ other *(explain)*

☐ left bank ☐ right bank ☑ center stream

(looking DOWNSTREAM to determine left/right bank)

☑ Off Bridge?: If so… ☑ upstream side ☐ downstream side

☑ basket used ☐ Van Dorn bottle used (Serial #)

☐ Upstream of a discharge ☐ Downstream of a discharge Discharge Description: —

☐ Tidal Information: ☑ Not Applicable, or… Samples taken during… ☐ Ebb (outgoing tide) ☐ Flow (incoming tide) ☐ Slack tide ☐ Indeterminable

General Notes:

Sample-Specific Notes:

B = fecal and E. coli
C = hardness (WES)
Color + turb. in 1 bottle

OWMID #	Sample Time	Analyte/Bottle Group										Sample Type							QA/QC			Total # of Bottles
												Grab			Composite							
> "X" all applicable boxes > Provide sample times for all samples > Provide separate OWMID#s for each matrix and sample type, and for QA/QC samples. > Affix ID labels in boxes below	(24 hr)	Chemistry (C)	Nutrients [1] (N)	Solids [2] (S)	Bacteria (B)	BOD/COD (D)	TOX [2] (T)	Chl a [2] (I)	Metals (M)	Color (R)	Other [2]	Manual Grab	Basket	Sampling Pole	Width/Depth Integrated	Flow Composite	Time Composite	Other [2]	Field Blank	Duplicate [3]	Other [2]	
33-2560	11:50	X	X		X					X			X							X		4
33-2561	11:50	X	X		X					X			X							X		4
33-2562	11:58	X	X		X					X									X			4
Affix OWMID # Label here																						
Affix OWMID # Label here																						
Affix OWMID # Label here																						

preservatives used *(for water matrix nutrients) (check one)* ☑ 1:1 H_2SO_4 ☐ 9N H_2SO_4 ☐ 1:1 HCl ☐ To Be Frozen ☐ HNO3 *(metals)*

[2] *describe more specifically in notes if needed.*

[3] ***for duplicate samples:*** *use different ID# for each sample, check 'Duplicate' column for each ID*

Multi-Probe DATA *Record last STABLE readings per Multi-probe SOP. For TDS/Salinity in table, circle one as applicable.* *Make sure to use a different* ***ID# for Multi-probe (or single probe) data.***

OWMID#: 33-2563

Sonde #: 15486

Logger #: 31160

Manual (watch) Time *(24 hr)*: 12:15

Depth calibrated at *(24 hr)*: 12:10

Multi-probe (sample-specific) Notes: used anchor assembly from old RR x-ing

Single Probe used? ☐ Yes ☑ No

Single Probe Model and Serial #: —

Time	Temp. (°C)	DO (mg/l)	Depth (meters)	Scond (µS/cm)	pH	% Sat	Turb (NTU)	TDS/Salinity (g/l)/(ppt)	Redox (mV)
12:17	22.10	7.85	0.9	195	6.81	89.6	—	.184	—

Cooler Temperature (post sampling at Lab): 2.3°

Project Lead (initial) S.A.

Example of completed 2005 Rivers Field Sheet (side two).

Massachusetts Department of Environmental Protection/Division of Watershed Management

Lake and Pond Survey Field Sheet

2005

Project Lead (initial) C.N. **Station Sheet** 1 **of** 1.

General Information *(fill out prior to departure)*

PROJECT Lakes Baseline	**General weather conditions last 3 days at:** Templeton
Lake Queen Lake	*http://www.erh.noaa.gov/box/dailystns.shtml* ***(See attached NOAA weather report)***
Town Phillipston	
PALIS # 35029	**Sampling Survey Crew** *(full names; last name only is OK for year round DWM employees):*
Site Name "A" deep hole	**Crew Lead:** C. Nemo **Others:** J. Cousteau

Station Information *(fill out at station)*

Date 6/19/05 **Time** (24 hr.) 11:39 **am** ✓ **pm** **Photos taken?** ☒ yes □ no **Van Dorn ID#:** 652792

Station Description and Access *(describe precisely where samples are taken using shore markers, GPS, etc. Also, note any posted restrictions on access)*

Boat launch @ beach (south end). Deep hole ½ way up lake in between large brown house (west side) and blue house (eastside)

Aquatic Plant Survey conducted? □ yes ☒ no

"Deep Hole" sampled? ☒ yes □ no **Samples or Measurements Taken?** ☒ yes □ no **If not, why?:** —

Lake Level Measurement *(if available, note source/type):* — □ Low (estimate minus ___ feet) ☒ Normal □ High (estimate plus ___ feet)

Current Weather *(check one only)*	**Air Temp**	**Wind Conditions**	**Water Odor** *(surface)*	**Water Clarity** *(check one only; if unobservable, note why)*	**Water Color** *(color at ½ Secchi depth as appears on white Secchi parts)*
☒ Clear	□ <20°F	□ Calm (0-1 mph)	☒ None	□ Unobservable	□ Unobservable ( )
□ Mostly sunny	□ 20-30	□ Slight breeze (1-5 mph)	□ Sulfide (rotten egg)	☒ Clear	□ Clear ☒ Light yellow
□ Mostly cloudy	□ 30-40	☒ Moderate winds (5-15 mph)	□ Fishy □ Raw sewage	□ Slightly turbid	□ Greyish □ Dark tan
□ Overcast	□ 40-50	□ Gusty (15-25 mph)	□ Septic	□ Moderate turbid	□ Brownish □ Rusty (orangish)
□ Foggy	□ 50-60	□ Strong winds (> 25 mph)	□ Chlorine	□ Highly turbid/ suspended solids/ murky	□ Blackish □ Greenish
□ Drizzly	☒ 60-70		□ Petroleum		□ Reddish □ Blue
□ Rain	□ 70-80		□ Musty (basement)		□ Other
□ Sleet □ Snow	□ 80-90		□ Rotten vegetation		
	□ 90-100		□ Other		

Wind Direction *(blowing from the .)*	**Wave Height**	**Algae @ Station** *(0-1 m. deep; check ONE only)*
□ Calm	□ Calm (0 in)	□ None □ Dense *(50-75%)*
□ North □ East	☒ 0-2 in	☒ Sparse *(~1-25%)* □ Very Dense *(75-100%)*
□ Northeast	□ 2-5 in	□ Moderate *(25-50%)* □ Floating scum
☒ Northwest	□ 5-10 in	**Algae Description** *(describe shapes if possible: spherical, filaments, etc.; genus/sp. if known):* —
□ South □ West	□ 10-15 in	
□ Southeast	□ 15-20 in	
□ Southwest	□ >20 in	

Aquatic Plants @ Station *(check ONE for each and list exotics)* Sparse *(~1-25%)* Moderate *(25-50%)* Dense *(50-75%)* Very Dense *(75-100%)*

Floating (F)	**Emergent (E)**	**Submerged (S)**	**Overall density**
☒ None	☒ None	☒ None	☒ None
□ Sparse	□ Sparse	□ Sparse	□ Sparse
□ Moderate	□ Moderate	□ Moderate	□ Moderate
□ Dense	□ Dense	□ Dense	□ Dense
□ Very Dense	□ Very Dense	□ Very Dense	□ Very Dense

% Duckweed: 0 % **Exotics:** —

Whole Lake Information *(fill out for the lake as a whole, check multiple boxes if applicable and note locations of observations; if unobservable, note why)*

Aquatic Plant Cover (WHOLE LAKE) □ Unobservable □ None ☒ Sparse *(~1-25%)* □ Moderate *(25-50%)* □ Dense *(50-75%)* □ Very Dense *(75-100%)*

- Describe dominant plants *(in order of dominance; circle type (E, S, F); also list any EXOTICS)*: 1) Potamogeton (E / S / F)
- Is Duckweed present on the lake? ☒ no □ yes (0 %) 2) ______ (E / S / F)
- If wind-driven, average width of Duckweed band at shore: — meters 3) ______ (E / S / F)
- **Exotics:** □ Trapa □ Cabomba □ P. crispus □ Egeria □ Nymphoides pelt. (yellow) □ Lythrum 4) ______ (E / S / F)
  □ Najas minor □ Phragmites □ Milfoil (□ spicatum □ heterophyllum □ aquaticum □ Other) 5) ______ (E / S / F)

Floating Scum(s) □ unobservable □ no ☒ yes *If yes:* □ oil sheens ☒ pollen/dust blankets □ algal mat □ foam □ other
- Describe Scum(s): very light dusting on surface
- If wind-driven, average width of algal mat band at shore: — meters

Uses Observed □ unobservable □ no □ yes *If yes:* □ swimming ☒ boating □ water intake □ fishing □ other
Description of Observed Use(s) or Indicators of Use(s) *(include numbers as applicable)*:

Objectionable Deposits □ unobservable ☒ no □ yes *If yes:* □ trash □ flocculent mass □ other
Description of Objectionable Deposits *(type, extent and area affected...)*:

Shoreline Erosion □ unobservable ☒ no □ yes *(note locations for undercut banks, existing and potential slope failures, landslides, etc.)*
Description of Erosion:

Wildlife Sightings □ unobservable ☒ no □ yes *If yes:* □ fish □ mammals □ birds □ reptiles □ waterfowl □ amphibians □ other
Description of Wildlife Sightings and/or Indications *(e.g. geese droppings, nests, etc.; include numbers as applicable)*:

Potential Pollution Sources □ none □ outfall pipes *(storm, wwtp, etc.)* □ garbage dumping □ land clearing ☒ lawns □ septic □ road runoff □ other
Description of Potential Pollution Sources: a few lawns down to water edge

For office use only **Field Sheet Login #** ______ **Unique ID #** ______ Revision Date 3/2005

Example of completed 2005 Lakes Field Sheet (side one).

LB-5680

SAMPLE DATA

Bottle Sample(s) collected?	☒ Yes ☐ No	VAN DORN Serial # : 652792	(if >1 used, clarify in notes)
Secchi Time (24 hr.)	12:21 am___ pm ✓		
Secchi depth (m)	3.8 Dup. 3.9	General Notes:	
Secchi viewfinder used?	☒ Yes ☐ No		
Secchi on bottom?	☐ Yes ☒ No		
Secchi in weeds?	☐ Yes ☒ No	Sample-Specific Notes: 9.0 m. B sample clear - OK	
Secchi taken in sunlight?	☐ Yes ☒ No		
Station Maximum Depth (m)	9.4		

Maximum Depth Method ☐ Secchi disk line ☒ Lead line ☐ Sonar ☐ Survey rod ☐ Other: ____

> "X" all applicable boxes
> Provide sample times for all samples
> Provide separate OWMID#s for each matrix and sample type, and for QA/QC samples.
> Use sequential last digits in OWMIDs (1,2,3...)

OWMID #	Sample Time (manual; 24 hr.)	Sample Depth (m): Relative Depth (S, M, NB) [4]	Sample Depth (m): Measured depth/ Integrated depth	Matrix: Sediment (Z)	Matrix: Water	Analyte/Bottle Group: Chemistry (C)	Nutrients [1] (N) [2]	Solids (S)	Bacteria (B)	Chlorophyll a (I)	Algae (A)	Zoops (G)	Color (R)	Other [2]	Sample Type (1 per sample): Grab: Manual Grab	Van Dorn Bottle [2]	Petite Ponar	Composite: Depth Integrated/tube	Grab Composite	Other [2]	QA/QC: Field Blank	Duplicate [3]	Other [2]	Total # of Bottles
LB-5681	12 25				X		X						X			X					X			2
LB-5682	12 30				X					X								X			X			1
LB-5683	12 35	S			X		X						X		X							X		2
LB-5684	12 35	S			X		X						X		X							X		2
LB-5685	12 41	B			X		X									X								1
LB-5686	12 46		0-8		X					X								X				X		1
LB-5687	12 46		0-8		X					X								X				X		1
__-_____																								

[1] preservatives used *(for water matrix nutrients) (check all that apply)* ☒ 1:1 H_2SO_4 ☐ 9N H_2SO_4 ☐ 1:1 HCl ☐ To Be Frozen (10)
[2] *describe specifically in notes*
[3] **for duplicate samples:** *use different ID# for each sample and check 'Duplicate' column for each ID* [4] **[S=surface M=mid-depth NB=near bottom]**

Multi-Probe DATA

Record last (stable)readings at each depth. Use another field sheet form if more rows needed. For TDS or Salinity, circle one. *__Make sure to use a separate, unique ID# for Multi-probe data.__* *If single probe units used, specify in notes.*

OWMID#: LB-5680	Sonde #: 15486	Logger #: 31160	
Duplicate readings taken? ☐ Yes ☒ No	Multiprobe (sample-specific) Notes:		
Duplicate OWMID#: —			
Manual (watch) Sample Time (24 hr): 12 05			
Depth calibrated at (24 hr): 12 01			
Single Probe used? ☐ Yes ☒ No	Single Probe Model and Serial #: —		

Time	Temp. (°C)	DO (mg/l)	Depth (meters)	Scond (µS/cm)	pH	% Sat	Turb (NTU)	TDS/Salinity (g/l)/(ppt)	Redox (mV)
12 04	19.15	7.88	0.5	492	7.48	83.5		0.321	
12 08	18.42	7.99	1.5	495	7.56	81.6		0.317	
12 12	17.98	8.32	2.5	479	7.58	80.5		0.323	
12 16	16.26	8.12	3.5	481	7.81	80.1		0.341	
12 20	14.55	7.51	4.5	495	7.75	78.5		0.333	
12 24	14.26	6.01	5.5	469	7.49	72.1		0.307	
12 29	12.95	4.32	6.5	469	7.28	70.5		0.297	
12 34	11.26	3.92	7.5	481	7.11	70.0		0.291	
12 39	11.10	3.18	8.5	495	6.92	68.9		0.297	
12 43	10.67	1.42	9.0	512	6.68	67.6		0.288	
~~12 50~~ C.N.									

Cooler Temperature (post sampling at Lab): 1.8 deg. C Project Lead (initial) C.N.

Example of completed 2005 Lakes Field Sheet (side two).

Massachusetts Department of Environmental Protection/Division of Watershed Management

Rivers and Streams

Project Lead (initial) RC.

Probe Deployment

Station Sheet 1 of 1.

Site and Survey Information			
Project: Ipswich	General weather attached for last 3 days at: Lawrence		
River: Ipswich R.	Current weather: Sunny		
Town: Ipswich	Crew Lead: R. Chase	Other(s): B. Friedman	
Site Name: IR06	Probe Type: ☒ DO/T ☐ TEMP	☐ DO/T/pH/Cond.	☐ Other
OWMID #: 92-2564	Sonde ID#: 4105	Tube #: 5	

DEPLOYMENT *(Determine left or right bank by looking downstream.)*

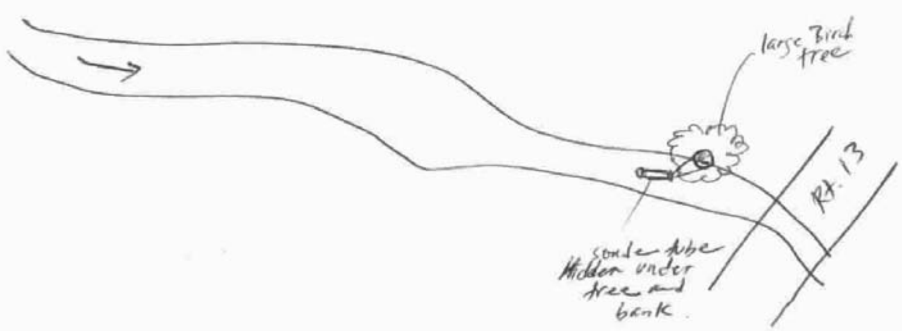
START Date: 8/13/05 Time (24 hr): 10:24 AM ✓ PM ___ Photos taken? Yes ✓ No ___

Apparatus *(check all that apply)* ☒ ABS tube ☒ anchor block ☒ cable & locks security ☒ storage cup removed?

Probe deployment depth *(in feet)*: 1.2' **Relative Depth:** ☐ Surface ☐ Mid-depth ☒ Near bottom

Deployment site--- *general description of site & access AND detailed description & sketch of installation:*

Approx. 15' upstream of IR06 (proper) site at Rt. 13 bridge. Tube anchored w/ block and to large birch tree on left bank. Tube well hidden under tree and undercut bank.



Sample-specific comments: Good site; sonde directed upstream OK.

Est. water velocity: ☐ ~0 fps ☒ < 1 fps ☐ 1 - 3 fps ☐ 3 - 5 fps ☐ >5 fps

Water Odor: ☐ None ☐ Sulfide ☐ Chlorine ☒ Petroleum ☐ Musty ☐ Sewage/Septic ☐ Other:

Water Clarity: ☐ Clear ☒ Slightly turbid ☐ Moderately turbid ☐ Highly turbid

Water Color: ☐ Clear ☐ Greyish ☒ Brownish ☐ Blackish ☐ Yellow/Tan ☐ Rusty/Reddish ☐ Other

NON-DEPLOYED PROBE DATA *(for QC only; at deployment, manually record applicable readings)*

OWMID#: do not use at deployment

Sonde #: 15486

Logger #: 31160

Manual (watch) Time *(24 hr)*: 1055

Non-deployed sample-specific probe notes: —

Depth calibrated at *(24 hr)*: 1050

Time	Temp. (°C)	DO (mg/l)	Depth (meters)	Scond (μS/cm)	pH	% Sat	Turb (NTU)	TDS/Salinity (g/l)/(ppt)
1056	23.45	5.21	0.35	415	6.71	68.7	—	0.594

For office use only: Field Sheet Login # Unique ID: Revision Date 03/2005

Example of completed 2005 Probe Deployment Field Sheet (side one).

RETRIEVAL *(Determine left or right bank by looking downstream.)*

END Date: 8/15/05 **Time (24 hr):** 11:10 AM ✓ PM ___ **Photos taken?** ☑ yes ☐ no

Evidence of sonde movement during deployment? ☐ yes ☑ no **Sonde submersed in water?** ☑ yes ☐ no

Crew Lead: R. Chase **Other(s):** B. Friedman

Observations (sample-specific comments)---- *description of retrieval*

Site looked the same, except for some debris on cable – should not have affected results. Good flow still. Probes in the still in water – no dirt buildup around probes.

Packed up and redeployed tube #5 at IR 07 on same day.

R. C.

NON-DEPLOYED MULTI-PROBE DATA (for QC duplicate using separate OWMID#; at retrieval)

OWMID#: 92-2565 **Sonde #:** 15486 **Logger #:** 31160

Manual (watch) Time (24 hr): 11:21

Depth calibrated at (24 hr): 11:18

Non-deployed multi-probe notes:

Time	Temp. (°C)	DO (mg/l)	Depth (meters)	Scond (µS/cm)	pH	% Sat	Turb (NTU)	TDS/Salinity (g/l)/(ppt)
11:25	23.59	6.11	0.4	410	~~68~~ RC 6.83	74.2	—	0.590

3/2005 **Project Lead** (initial) RC

Example of completed 2005 Probe Deployment Field Sheet (side two).

Massachusetts Department of Environmental Protection/Division of Watershed Management

Rivers and Streams

Project Lead (initial) S.P. **Pipes and Closed Conduits** Station Sheet 1 of 1.

General Information

Project: Millers	General weather attached for last 3 days at: Erving
River discharging to: Millers R.	Current survey weather: mostly Cloudy
Town: Mayberry	Crew Lead: S. Parker
Site Name: MR 08 B	Other Crew: B. Fife

Site Information (Determine left or right bank by looking downstream.)

Date: 8/15/05 Time (24 hr): 10²⁰ AM ✓ PM ___ Photos taken? Yes ✓ No ___

Sampling Location *(describe where and how sampled, including how accessed):*

~100' upstream of MR 05 station on right bank. Saw grey plume — walked from MR 05 to MR 08 B along bank — sampled from bank at end of pipe — good sample.

Source Water: ☐ stormwater ☐ WWTP outfall ☑ sewer (illicit) ☐ CSO ☐ unknown ☐ other:

Type: ☐ plastic ☑ concrete ☐ metal ☐ clay/brick ☐ other:

Pipe Size (ID): ☐4" ☑6" ☐12" ☐18" ☐24" ☐30" ☐36" ☐42" ☐48" ☐ other:

Est. pipe slope (in feet per 100'): ☐.5' ☐1' ☑3' ☐5' ☐10' ☐20' ☐30' ☐ other:

Est. water velocity in pipe: ☐ ~0 fps ☑ < 1 fps ☐ 1 - 3 fps ☐ 3 - 5 fps ☐ >5 fps

Est. water height in pipe (in feet): 0.25' (3")

Water Odor: ☐ None ☐ Sulfide ☐ Chlorine ☐ Petroleum ☐ Musty ☑ Sewage/Septic ☐ Other:

Water Clarity: ☐ Clear ☐ Slightly turbid ☐ Moderately turbid ☑ Highly turbid

Water Color: ☐ Clear ☑ Greyish ☐ Brownish ☐ Blackish ☐ Yellow/Tan ☐ Rusty/Reddish ☐ Other

Field Probe(s) used? Yes ___ No ✓; *(If so, describe unit and ID#, and manually record results on back of fieldsheet)*

Observations (continue on back, with sketch as needed):

looks like old (forgotten pipe). Strong odor. good flow

small black clumps in very turbid, grey water

poss. filamentous bacteria (sphaerotilus natans ...)

Sample Collection

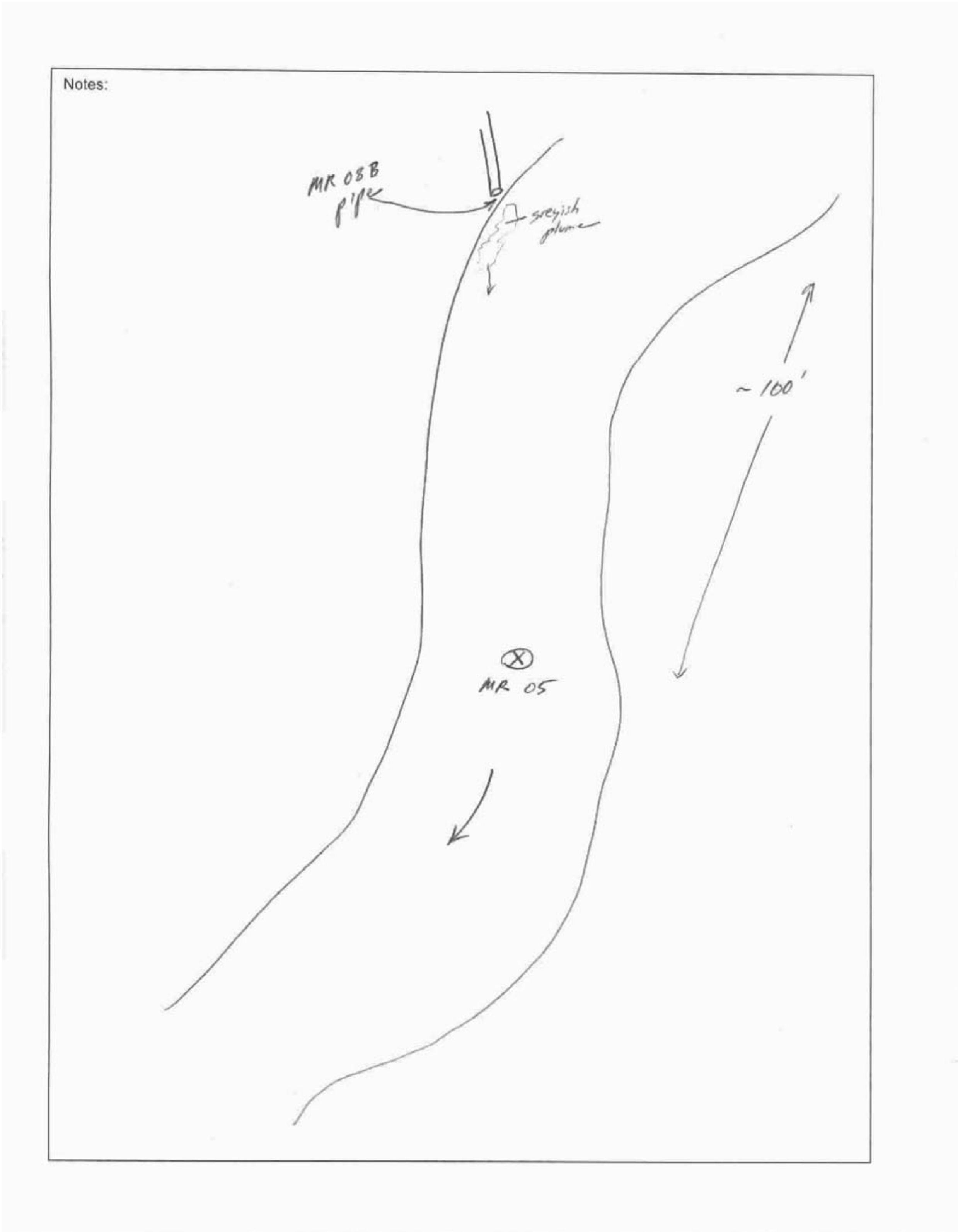
Sample Notes: good samples from outfall ; no chlorine smell

OWM ID (affix sample ID label in boxes below)	Sample Time (24 hr)	Analyte: Chemistry (C)	Nutrients (N)	Solids (S)	Bacteria (B)	BOD/COD (D)	TOX (T)	Metals (M)	Other *	Sample Type: Manual Grab	Sampling Pole	Time Composite	Other	QA/QC: Blank	Duplicate	Other	Total # of bottles
35-2562	10²²		X	X	X					X							3
Affix OWMID # Label here																	
Affix OWMID # Label here																	

*Write in code: A = Algae, DNA = Bacteroides, FWA = Fluorescent Whiting Agents, OB = Optical Brightener, R = Apparent Color

For office use only: Field Sheet Login # Unique ID: Revision Date 3/2005

Example of completed 2005 Pipe Sampling Field Sheet (side one).



Example of completed 2005 Pipe Sampling Field Sheet (side two).

Massachusetts Department of Environmental Protection/Division of Watershed Management

Rivers and Streams

Project Lead (initial) J.S.

Bacteria Source Tracking (Rivers)
2005

Station Sheet 1 of 1.

General Information (*fill out prior to departure*)

Project	Deerfield	**General weather attached for last 3 days at:**	Greenfield
River	Green River	**Current survey weather:**	sunny
Town	Greenfield	**Crew Lead:**	J. Smith
Station ID	GR09	**Other Crew:**	R. Jones

Station Information (*within 10 meters up/down. Determine left or right bank by looking downstream*)

Date: 7/6/05 **Time (24 hr):** 1325 AM ___ PM ✓ **Photos taken?** Yes ✓ No ___

Station Description and Access: At Green River footbridge off Route 5. Pull off road and park near sign for footbridge trail. Go ~ 500' to bridge, then take path down to water, upstream side

Observations and potential pollution sources (*continue on back*): Dairy farm upstream, left bank (cows in water) →

Average Water Velocity: □ ~0 fps □ < 1 fps ☑ 1 - 3 fps □ 3 - 5 fps □ >5 fps

River Water Level: □ Low ☑ Normal □ High

Fixed-point vertical distance to water surface (ft.): — **Staff gage reading:** —

Conductivity readings taken: Yes ✓ No ___ **If yes, meter used and serial #:** YSI 33 SCT

Water Odor: □ None □ Sulfide □ Chlorine □ Petroleum □ Musty ☑ Sewage/Septic □ Other:

Water Clarity: □ Clear □ Slightly turbid ☑ Moderately turbid □ Highly turbid

Water Color: □ Clear □ Greyish ☑ Brownish □ Blackish □ Yellow/Tan □ Rusty/Reddish □ Other

Aquatic plant density: □ None □ Sparse (0-25%) ☑ Moderate (25-50%) □ Dense (50-75%) □ Very Dense (75-100%)

Film Periphyton: □ None □ Sparse ☑ Moderate □ Dense □ Very Dense

Filamentous Periphyton: □ None ☑ Sparse □ Moderate □ Dense □ Very Dense

Phytoplankton presence: ☑ None □ Suspended in water column □ Floating clumps/mats

Optical Brightener Samplers deployed? Yes ✓ No ___ **If yes, deploy/pickup dates:** 7/5 / 7/6

Sample Collection information (for in-stream only; for pipe discharges, use "Pipes" fieldsheet)

Type: ☑ wade in □ from shore □ bridge □ other:

Location: □ center stream ☑ left bank □ right bank □ other:

Tidal Information (if applicable): □ Ebb (outgoing) □ Flow (incoming) □ Slack tide □ indeterminable —

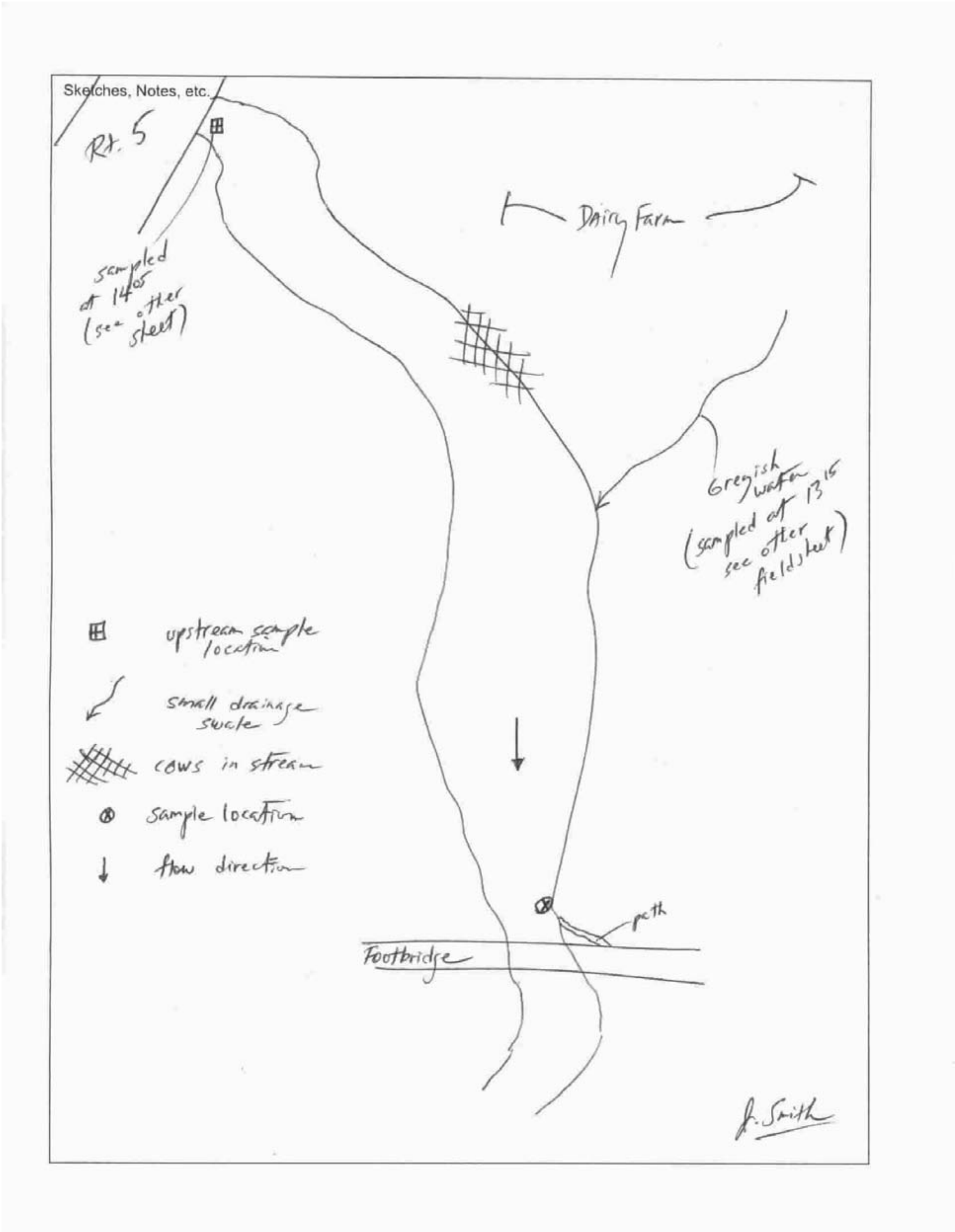
Preservative: ☑ $Na_2S_2O_3$ □ other:

OWM ID (affix sample ID label in boxes below)	Sample Time (24 hr)	Analyte: Bacteria (B)	Analyte: FWA	Analyte: Fluorometry	Analyte: Other*	Sample Type: Manual Grab	Sample Type: Sampling Pole	Sample Type: Other **	QA/QC: Blank	QA/QC: Duplicate	QA/QC: Other	Total # of bottles	Sample Notes **
33-2561	1335	X	X			X				X		2	Colilert (DWM) FWA (WES)
33-2562	1335	X	X			X				X		2	"
33-2563	1340	X	X						X			2	"

* Write in code: A = Algae, C = Chemistry, D = BOD/COD, DNA = Bacteroides/other, M = Metals N = Nutrients, R = Color, S = Solids
** If > 1 sampling method used for different samples, note differences

For office use only: Field Sheet Login # Unique ID: Revision Date 3/2005

Example of completed 2005 Bacteria Source Tracking Field Sheet (side one).



Example of completed 2005 Bacteria Source Tracking Field Sheet (side two).

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection
Senator William X. Wall Experiment Station

Sample Tracking & Chain-of-Custody Record

Cooler Temperature at Receipt 2.7 °C
6/19

WES Sample Log-In Batch # L2004-087

Agency-Bureau-Division-Region	
Bureau:	BRP
Division/Unit:	DWM-WP
☐ DEP WES	☐ DEP Boston
☐ DEP NERO	☐ DEP SERO
☐ DEP CERO	☐ DEP WERO
☐ Other Agency:	

Project Description	
Name:	Lakes TMDL
Coordinator:	E. Welch
Phone #:	508-767-2859
Fax #::	508-791-4131
RTN:	
Case #:	

Analytical Laboratory *(for samples sent to a laboratory other than WES)*	
Name:	—
Address:	
Contact:	
MA Cert#:	
Phone #:	

Sample Lab ID (Batch # above plus # below)	Sample Field ID	Site Name	Field Locator (Within Site)	Sample Matrix Code*	Collector (last name, first initial)	Collection Date	Collection Time	Sample Preserv. Code #**	G/C***	Chlorine Residual (yes/no)	Analysis Requested
	LB-3027	Blue Lake		SRW	Welch, E	6/19	12:45	1,2	G	no	TP
	LB-3028	Blue Lake		SRW	Welch, E	6/19	12:48	1,2	G	no	TP
	LB-3029	Blue Lake		SRW	Welch, E	6/19	12:55	1,2	G	no	TP
	LB-3030	Blue Lake		SRW	Welch, E	6/19	12:57	1,2	G	no	TP
	LB-3031	Blue Lake inlet		SRW	Welch, E	6/19	13:46	1,2	G	yes	TP
	LB-3032	Blue Lake inlet		SRW	Welch, E	6/19	13:47	1,8	G	yes	~~Fecal coliform,~~ E. coli E.W. 6/19

Remarks: * E. coli run @ DWM Lab (Colilert); TP samples to be delivered to WES next week.

Chain of Custody: ***(Required, including signatures, for all samples submitted to WES Laboratories)***

Relinquished by: Printed name	Signature	Org.	Date	Time	Received by: Printed name	Signature	Org.	Date	Time
E. Welch	E. Welch	DWM-WP	6/19	1655	R. Chase	R. C.	DWM-WP	6/19	1655
DWM Fridge	—	"	6/23	905	R. McVoy	Rick McVoy	"	6/23	905
R. McVoy	Rick McVoy	"	6/23	1110	J. Sullivan	J. Sull	WES	6/23	1110

*** Matrix Codes**
AC = Air Canister
ACT = Air Cartridge Tube
AF = Air Filter
DW = Drinking Water (Treatment and Distrib)
FBT = Fish/Biological Tissue
FEC = Feces/Fecal Matter
GRYW = Gray Water
GW = Ground Water
IWW = Industrial Wastewater
LL = Landfill Leachate
LW = Liquid Waste
ME = Marine/Estuarine Water
SED =-Sediment
SOIL = Soil
SRW = Surface Water
STW = Storm water/CSO
SW = Solid Waste
TB = Trip Blank (Type I Reagent Water)
UN = Unspecified Water/Wastewater
WO = Waste Oil
WW = Domestic Wastewater
WWS = Wastewater Sludge

**** Sample Preserv Codes**
1 = Cool ≤ 4° C
2 = pH < 2 with H_2SO_4
3 = pH < 2 with HNO_3
4 = pH < 2 with HCl
5 = pH > 12 with NaOH
6 = Ascorbic acid
7 = Filtered (0.45-μm pore size)
8 = Sodium thiosulfate ($Na_2S_2O_3$)
9 = Mercuric chloride ($HgCl_2$)
10 = Sodium sulfite (Na_2S)
11 = Ammonium chloride (NH_4Cl)
12 = Ethylenediamine
13 = EDTA
14 = Methanol
15 = Reagent Water (Type I)

***** G/C = Grab/Composite**

Rev. #2.0, February 2003
W:\dea-qap\COC-Form\COC form.doc

Example of completed 2005 WES COC Form (side one).

Massachusetts DEP/DWM **Biomonitoring Field Data Sheet** (page 1 of 2) Rev. Date: June 1999

Investigator(s) ____

River Basin __________________________ Stream Name ______________________________ Saris # ____________________

RECONNAISSANCE | HABITAT | INVERTEBRATE | FISH | FLOW | WATER QUALITY | ALGAE |

Describe Site Location: ____

STREAM CHARACTERIZATION

• Subsystem Classification
- □ Tidal
- □ Lower Perennial
- □ Upper Perennial
- □ Intermittent

• Stream type
- □ Coldwater
- □ Warmwater

RIPARIAN ZONE/INSTREAM FEATURES

•Surrounding Land Use
- _____% Forest
- _____% Field/Pasture
- _____% Agriculture
- _____% Residential
- _____% Commercial
- _____% Industrial
- _____% Other _____________________

• Local Watershed NPS Pollution
- □ No evidence
- □ Some potential sources_____________________________
- □ Obvious sources___________________________________

•Local Water Erosion
- □ None
- □ Slight
- □ Moderate
- □ Heavy

• High Water Mark _____m

• Dam Present □ Yes □ No

• Channelized □ Yes □ No

• Estimated Stream Width _____m

• Estimated Stream Depth
- Riffle _____m
- Run _____m
- Pool _____m

• Velocity
- _____ m/sec at deployment
- _____ m/sec at recovery

• Estimated Fish Reach Length _____m

• Canopy Cover ____%

SEDIMENT/SUBSTRATE

• Odors
- □ Normal
- □ Sewage
- □ Petroleum
- □ Chemical
- □ Anaerobic
- □ None
- □ Other________________

• Deposits
- □ Sludge
- □ Sawdust
- □ Paper fiber
- □ Sand

• Oils
- □ Absent
- □ Slight
- □ Moderate
- □ Profuse
- □ Relict shells
- □ Other ________________

• Are the undersides of stones not **deeply embedded black?**
- □ Yes
- □ No

INORGANIC SUBSTRATE COMPONENTS

Substrate	Diameter (Minshall 1984)	% Composition in Sampling Area	% Composition in Sampling Reach
C.		______ %	______ %
Boulder	>256mm (10in)	______ %	______ %
Cobble	64-256mm (2.5-10in)	______ %	______ %
Pebble	16-64mm (0.6-2.5in)	______ %	______ %
Gravel	2-16mm (0.1-0.6in)	______ %	______ %
Sand	0.06-2mm (gritty)	______ %	______ %
Silt	0.004-0.06mm	______ %	______ %
Clay	<0.004mm (slick)	______ %	______ %

D. ORGANIC SUBSTRATE COMPONENTS

Substrate	Characteristic	% Composition in Sampling Reach
E.	Sticks, wood, coarse plant materials (CPOM)	______ %
Muck-mud	Black, very fine organic (FPOM)	______ %
Marl	grey, shell fragments	______ %

WATER QUALITY

- **• Temperature** _____^{O}C
- • Specific Conductance _____
- • Dissolved Oxygen _____
- • pH _____
- • Turbidity _____
- • hydrolab H2O No. _____
- • hydrolab SRV3 No. _____
- • Other____________________

•Water Odors
- □ Normal/None
- □ Sewage
- □ Petroleum
- □ Chemical
- □ Fish
- □ Other

- □ Slick
- □ Sheen
- □ Globs
- □ Flecks
- □ None

- □ Clear
- □ Slightly turbid
- □ Turbid
- □ Opaque
- □ Water color ___________

Massachusetts DEP/DWM **Biomonitoring Field Data Sheet** Revision Date: June 1999

Investigator(s) ______________________________

River Basin ____________________ Stream Name ________________________

City/State ______________________________ Time ________

Describe Site Location ______________________________________

•Weather Conditions	storm (heavy rain)	rain (steady rain)	showers (intermittent)	% cloud cover	clear/sunny
Now	□	□	□	_____%	□
Past 24 hours	□	□	□	_____%	□

• **Has there been heavy rain in the past 7 days?**
□ Yes □ No

• **How were samples collected?**
□ wading □ from bank □ from boat

• **Riparian vegetation** (18 meter buffer)
Mark the dominant type and record the dominant species present
- □ **trees**
- □ **shrubs**
- □ **grasses**
- □ **herbaceous**

• **Aquatic Vegetation (coverage within reach: _____%)**
Mark the dominant type and record its percent coverage; record the dominant species present.
- □ **rooted emergent** _____%
- □ **rooted submergent** _____%
- □ **rooted floating** _____%
- □ **free floating** _____%
- □ **mosses** _____%

• **Algae (coverage within reach: _____%)**

forms	**color**			**substrate**				**microhabitat**		
	green	brown	other	rock	wood	plant	other	pool	riffle	other
□ **filamentous**	□	□		□	□	□		_____%	_____%	
□ **flock**	□	□		□	□	□		_____%	_____%	
□ **thin film**	□	□		□	□	□		_____%	_____%	
□ **other** __________	□	□		□	□	□		_____%	_____%	

	Riffles	Snags	Stream Banks	Submerged Macrophytes	Other
• **Number of jabs/kicks taken in each habitat type:**					
• **Percent Habitat Types:**	____%	____%	____%	____%	____%

• **Site/location map** (Draw a map of the site and indicate the areas sampled.)

• **General comments:**

FISH FIELD DATA SHEET (**FRONT SHEET**)

Site/Project# **Sample ID Code**

Location ______________________ Waterbody Name ______________________

Type of Sample (Gear) ______________________ Date Sampled ______________________

Fish Identified by ______________________ Page ___ of ___

SPECIES	TOTAL	LENGTH (mm) /WEIGHT (g)					ANOMALIES*							
	(COUNT)	(25 SPECIMEN MAX SUBSAMPLE)					D	E	F	L	M	S	T	Z

Anomaly Codes; D = deformities; E= erodes fins; F = fungus; L = lesions; M = multiple DELT anomalies; S= Emaciated; T = tumors; Z= other

FISH FIELD DATA SHEET (**BACK SHEET**)

Site/Project# **Date Sampled**

SPECIES	TOTAL (COUNT)	LENGTH (mm) /WEIGHT (g) (25 SPECIMEN MAX SUBSAMPLE)					ANOMALIES* D	E	F	L	M	S	T	Z

Anomaly Codes; D = deformities; E= erodes fins; F = fungus; L = lesions; M = multiple DELT anomalies; S= Emaciated; T = tumors; Z= other

Massachusetts DEP/DWM **Habitat Assessment Field Scoring Sheet** (page 1 of 2)Revision Date: June 1999

Investigator(s) ______________________ Reference Site ______________________

River Basin ______________________ Stream Name ______________________ Saris # ______________________

Describe Site Location: ______________________

Protocols for Wadable Riffle/Run Prevalent Streams: those in moderate to high-gradient landscapes that sustain water velocities of approximately 30 cm/sec or greater. Natural streams have substrates primarily composed of coarse sediment particles (i.e., gravel or larger) or frequent coarse particulate aggregations along stream reaches.

Habitat Parameter	**Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Instream Cover **(Fish)**	A mix of snags, submerged logs, undercut banks, rubble, or other stable habitat in greater than 50% of the sample area	30-50% of area with a mix of stable habitat; adequate habitat for maintenance of populations	10-30% of area with a mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% of area with a mix of stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Epifaunal Substrate **(in sampled area only)**	Well-developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; abundance of cobble. (Boulders prevalent in headwater streams).	Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or bedrock prevalent; some cobble present.	Riffles or runs virtually nonexistent; bedrock prevalent; cobble lacking.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Embeddedness **(riffles/runs)**	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 y) may be present, but recent channelization is not present.	New embankments present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Massachusetts DEP/DWM **Habitat Assessment Field Scoring Sheet** (page 2 of 2) Revision Date: June 1999

Habitat Parameter	Category: Optimal	Suboptimal	Marginal	Poor
6. Velocity-Depth Combinations 1. slow deep 2. fast deep 3. slow shallow 4. fast shallow **(frequency of riffles or bends)**	**All 4 velocity/depth patterns present**. Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstructions is important.	**Only 3 of 4 velocity/depth patterns present** (i.e., slow [<0.3 m/s]-deep [>0.5 m]; slow-shallow; fast-deep; fast-shallow). Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	**Only 2 velocity/depth patterns present**; usually lacking deep areas. Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	**Dominated by one velocity/depth pattern**. Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE ______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces covered by naturally occurring vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; **almost all plants allowed to grow naturally**.	70-90% of the streambank surfaces covered by naturally occuring vegetation, but one class of plants is not well-represented; **disruption evident but not affecting full plant growth** potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; **disruption obvious**; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; **disruption of streambank vegetation is very high**; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ______ **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ______ **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Bank Stability (score each bank)	Banks stable; evidence of erosion or **bank failure absent or minimal**; little potential for future problems. <5% of bank affected.	Moderately stable; **infrequent, small areas of erosion mostly healed over**. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; **high erosion potential during floods**.	Unstable; many eroded areas; **"raw" areas frequent along straight sections and bends**; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ______ **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ______ **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of **riparian zone >18 meters**; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of **riparian zone 12-18 meters**; human activities have impacted zone only minimally.	Width of **riparian zone 6-12 meters**; human activities have impacted zone a great deal.	Width of **riparian zone <6 meters**: little or no riparian vegetation due to human activities.
SCORE ______ **(LB)**	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ______ **(RB)**	Right Bank 10 9	8 7 6	5 4 3	2 1 0

TOTAL SCORE ______

comments:

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION, DIVISION OF WATERSHED MANAGEMENT
Aquatic Macroinvertebrate Data Sheet

Watershed: **Waterbody name:** **Station Code #:** **Date collected:**

Location description:

Collector:
Sorted by:
Sample Type:

Taxonomist:

Form revision date: 20 August 2002

Mollusca
Gastropoda

Pelecypoda

Annelida
Oligochaeta

Hirudinea

Crustacea
Isopoda

Amphipoda

Decapoda

Hydracarina

Insecta
Ephemeroptera

Odonata

Plecoptera

Megaloptera

Trichoptera

Coleoptera

Diptera (Chironomidae spp. on back)

Other Insecta

Other Invertebrata

Life stage is larva, nymph, or naiad, unless indicated as: (P) = pupa or (A) = adult
Total No. of Organisms: Total No. of Kinds:
Family QC check completed by: Genus/species QC check completed by:
date: date:

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION/DIVISION OF WATERSHED MANAGEMENT

Aquatic Macroinvertebrate Data Sheet

WATERSHED NAME: WATERSHED CODE:

SLIDE BOX: ______ of ______ SURVEY DATE:

SLOT/ STATION	COVER/TAXA	COMMENTS	SLOT/ STATION	COVER/TAXA	COMMENTS
____/________	A/____________________		____/________	A/____________________	
	A/____________________			A/____________________	
	A/____________________			A/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
____/________	A/____________________		____/________	A/____________________	
	A/____________________			A/____________________	
	A/____________________			A/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
____/________	A/____________________		____/________	A/____________________	
	A/____________________			A/____________________	
	A/____________________			A/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
____/________	A/____________________		____/________	A/____________________	
	A/____________________			A/____________________	
	A/____________________			A/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
____/________	A/____________________		____/________	A/____________________	
	A/____________________			A/____________________	
	A/____________________			A/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	
	B/____________________			B/____________________	

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION/DIVISION OF WATERSHED MANAGEMENT

WATERSHED NAME: WATERSHED CODE:

SURVEY DATE:

STATION #								
STREAM								
HABITAT SCORE								
TAXA RICHNESS								
BIOTIC INDEX								
EPT INDEX								
EPT/CHIRONOMIDAE								
SCRAPERS/FILTERERS								
% DOMINANT TAXON								
COMMUNITY SIMILARITY								
TOTAL METRIC SCORE								
% COMPARABILITY TO REFERENCE STATION	100%							
BIOLOGICAL CONDITION -DEGREE IMPAIRMENT	REFERENCE							

HAZARDOUS WASTE GENERATION RECORD
Month_________Year________

Date	Initials	Description	Volume or weight

Field Survey Checklist

Note: Use as a guide to review what you need to take; "standard" items are generally REQUIRED)

STANDARD (rivers, lakes)		**OPTIONAL**	
Complete Field Kit (see Items List)		Flow Measurement Kit (see Items List)	
Complete Field First Aid Kit		Ponar sediment sampler	
Emergency phone numbers		Machete/weed cutter	
Multiprobe with data recorder		Cellular phone (recommended)	
Spare battery for Multi-probe, other		Site-specific location maps	
Vehicle book		Project QAPP/SOPs as needed	
Field Notebook		GPS unit	
DWM Fieldsheet(s)		5 gal. Bucket for biological samples	
WES/contract lab (if applicable) C.O.C. Forms		Auxillary tool kit	
Sample bottle labels			
DWM OWMID numbers			
Sampling basket (inc. sand-filled bottles and weights)			
Van Dorn/Kemmerer sampler (if needed; lakes)			
Required sample bottle number and size(s), including those for blanks and duplicate QC samples			
Cooler(s) with thermometers			
Ice for cooler(s)			
Acid preservation kit (1:1 H_2SO_4 with pipettes in plastic zip-lock bag)			
Depth sounding device			
Secchi disc			
Viewscope (Secchi)			
Boat, motor, gas, oars, oarlocks, rope, anchor, etc. as approp.…			
Personal flotation device(s): 1 for each boat occupant			
Weighted hose sampler (Chl a)			
Metal clipboard			
Camera and film (high resolution digital preferred)			
Field umbrella			
Safety vests (one for each monitor)			
Personal rain gear, sunglasses and hat			
Waterproof boots (length as approp.)			
Emergency rations and drinking water			

Field Kit Items:	√
Standard:	
Extra markers (Sharpie, pen, pencil)	√
Rubber bands	√
Assorted gloves	√
Plastic sampling gloves (several pairs)	√
Tape measure	√
Flashlight	√
Sunscreen	√
Insect repellent	√
Bacteriocide lotion	√
Poison ivy/oak wash lotion	√
Foot ruler	√
CPR face mask	√
Safety glasses (1 pair)	√
pH strips	√
Electrical tape	√
Plastic tie wraps	√
Screwdriver	√
Optional: (not included as standard)	
Compass	
Moist towelettes/paper towels	
State map	
Polarized sunglasses	
Flow Measurement Kit Items: in addition to field survey/kit items above	
Tape pins (4-6)	√
Tape Measure/Tag line (2)	√
Flow meter (Price AA, Swoffer or Sontek ADV as appropriate)	√
Rickly counter/Swoffer indicator/Sontek data recorder (as appropriate)	√
Pens/pencils	√
Flow fieldsheets	√
Staff gages (as needed)	√
Stopwatch	√
Spare batteries	√

MULTI-PROBE PRE-CAL CHECKLIST & USER REPORT

(Please review Checklist prior to survey departure and complete/return User Report when returning Multi-probe to DWM .)

MULTI-PROBE PRE-CAL CHECKLIST

Project/Basin_______________ Monitoring Coordinator ______________________

Sent Items:

□ SONDE #____________	□ LOGGER # _____________	□ STIRRER # ___________
□ CHECK STD/DI H2O	□ STRAPS	□ LINKS
□ FIELD GUIDE	□ FIELD SHEETS	□ CLEAN RAG
□ CASE	□ CABLE _______ ft/m	□ AUX. BATT.
□ EDITED SITE LIST	□ FIELD STORAGE CUP	□ AUX. WEIGHT

Date/Time___________________ Multi-probe Calibrator (initials) ________

USER REPORT

Monitoring Coordinator ____________________ User Name____________________

Returned Items:

□ SONDE	□ LOGGER	□ STIRRER
□ CHECK STD/DI H2O	□ STRAPS	□ LINKS
□ FIELD GUIDE	□ FIELD SHEETS	□ DIRTY RAG
□ CASE	□ CABLE _______ ft/m	□ AUX. BATT.
□ EDITED SITE LIST	□ FIELD STORAGE CUP	□ AUX. WEIGHT

User Observations:

□ Sonde/sensor(s) malfunctioned _____
damaged _____
□ Bubbles observed under DO membrane
□ Stirrer spinning inconsistent
□ Case damaged
□ Data logger battery failed ____
malfunctioned ____
□ Readings could not stabilize for pH____ DO____ %Sat.____ Sp.Cond./Sal.____ Temp._____
Depth_____ Turbidity_____
□ Cable damaged _____
malfunctioned _____
□ No Problems

Comments:____

____

____

Date/Time___________________ User (initials) _______

PROJECT SAMPLE LABELS (Examples)

12-KC01 11 August 1997 Kinderhook Creek dnst. fr. Brodie Mountain Road, Hancock, MA coll. R. Nuzzo

Example of label to be placed in containers with <u>benthos samples</u>.

12-KC01 11 August 1997 Philopotamidae

Example of label to be placed in <u>benthos</u> specimen vials after sorting.

12-KC01 11 August 1997 Kinderhook Creek dnst. fr. Brodie Mountain Road, Hancock, MA <u>Chimarra</u> sp. det. R. Nuzzo

Example side label for <u>benthos</u> (orient the head with its ventral surface facing up).

Massachusetts DEP <u>Wall Experiment Station</u> Sample Field No.___________ Sample Lab No.____________

Example of label to be placed on <u>WQ bottles</u>.